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TRANSACTIONS & STUDIES

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Nutrition, Ageing and Longevity*

By CLIVE M. McCAY, PH.D.

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Health and disease are subjects that come within the province not merely of the physician but, so far as the consideration of their causes goes, within that of the natural philosopher. That these inquirers differ from each other and examine the subject from distinct points of view, must be fully recognized. Aristotle, *On Respiration.*

IN THE middle ages Roger Bacon appreciated that the problems of ageing were subject to the experimental attack when he stated, "Therefore in regard to this (lengthening the life span) we must strive, that the wonderful and ineffable utility and splendor of experimental science may appear and the pathway may be opened to the greatest secret of secrets" (1). Bacon also appreciated the nature of this field when he wrote, "But owing to the difficulty of this very great experiment, and because few take an interest in experiments, since the labor involved is complicated and the expense very great, and because men pay no heed to the secrets of nature and the possibilities of art, it happens that very few have labored in this very great secret of science and still fewer have reached a laudable end."

Some progress might have been made during the past centuries in studying the changes that come with age in the animal body. But, for the most part, only limited advances could have been anticipated because the importance of the vitamins had not been recognized. Physiology, biochemistry and nutrition were able to advance in some areas during the past two centuries because researches were limited to short time periods, and thus the body's store of vitamins was often adequate to prevent complications for a few months. However, if long time experiments had been tried they would usually have failed because of depletion of the reserves of some essential such as vitamin A. Advances in our knowledge of vitamins during the past half century have presented the opportunity for a modern attack upon the problems of ageing, and it is about these modern methods of attack that I shall tell you tonight.

Many writers, such as Roger Bacon and Metchnikoff, have asserted that man seldom completes a normal span of life. Bacon wrote, "All these accidents of old age and senility are white hair, pallor, wrinkling of the skin, excess of mucus, foul phlegm, inflammation of the eyes, and generally injury to the organs of sense, diminution of blood and of the spirits, weakness in motion and breathing and in the whole body, failure in both the animal and natural powers of the soul, sleeplessness, anger and disquietude of mind, and forgetfulness, of which the royal Hali says that old age is the home of forgetfulness and Plato that it is the mother of lethargy. . . . Because of the lack of a proper regimen of health all these accidents and many more come to men in the prime of life."

The concept of these characteristics of old age as "accidents" affords a suitable working hy-

* Nathan Lewis Hatfield Lecture XXVI, The College of Physicians of Philadelphia, February 4, 1942.

pothesis to discover means of preventing them. All writers have realized that each species has its own span of life but most have confessed that they do not know the outer limits of this span.

In undertaking experiments in the field of ageing one is first confronted by the choice of a suitable experimental animal. The life span of the chosen species should be relatively short. Its nutritional requirements should be similar to those of man. It should be a large enough animal for the application of physiological testing techniques in order to evaluate the degree of senility.

Insects may seem very promising because of their short span of life but their nutrition is poorly defined and they are small for many types of testing. Herbivorous species such as sheep, rabbits and guinea pigs may become useful but today their nutrition is not well understood. The most suitable species, then, seem to be the rat, the mouse, the dog and the chicken. Some lesser known ones such as the golden hamster, are promising. The dog would undoubtedly be the best except that its span of life is relatively long. Furthermore, some small animal clinicians maintain that different breeds age at very different rates. The selection of a suitable breed, therefore, would have to be made carefully. A dog would be large enough for functional tests. The diseases that afflict it in old age are similar to those of man. Its nutrition is similar to that of man except that it does not need vitamin C in its diet and is not subject to scurvy.

Next to the dog the rat is the most suitable today. Its nutrition is well defined. Its mean span of life is about two years. For a rough comparison with man, one usually considers ten days in the life of a rat, equal to a year in that of man. For functional testing the rat is somewhat too small. As far as the pathologist is concerned the rat is not entirely satisfactory because the diseases that occur in its old age are quite different from those of man, although the same organs are involved, such as the lungs and the kidneys. The bones of rats change in age much like those of man. The heart tends to remain normal even in old age. The arteries may or may not show calcification. The rat is subject to tumors to about the same extent as man.

In spite of the thousands of studies that have been made to define the nutritional requirements of the rat, only a few of these have been concerned with any portion of the life span other than the first few months which cover the growing period. A few attempts have been made to keep rats upon diets throughout life and determine the effect of these upon the span. Professor Sherman and coworkers (2) have found that dietary factors such as the level of milk and the level of calcium in the diet may be important in extending the span of life. Slonaker found the level of protein in the diet to be an important factor (3). Drummond and others (4) fed rats a mixture comparable to a poor diet for man, with and without the addition of 15% wheat germ. The experiment was run in two different laboratories in England. In both cases the rats fed the supplement lived longer, but the life spans of the poorest groups in one colony were longer than the best in the other, indicating that some factor in environment had modified the results. This literature has been summarized elsewhere (5). The constancy of the external environment may be of great importance in comparing nutritional variables in different laboratories, if the English experiment is a criterion. The experience of Mills at Cincinnati and Peterson in Chicago would serve to emphasize the importance of many factors in the environment other than nutrition in determining the span of life.

With this brief and rather inadequate introduction we will describe some of the studies at Cornell during the past fifteen years. Most of these have been made with the white rat and most of the emphasis has been upon nutrition. In general the plan of attack has consisted in feeding diets of known composition for long periods of time and attempting to evaluate the results by the techniques of the pathologist, the biochemist, the physiologist and the histologist.[1]

Three methods of attack upon the nutritional aspects of ageing have been used in the Cornell studies, namely: (1) the feeding of a constant diet throughout life in liberal amounts; (2) the feeding of a uniform diet during the first half of life with the introduction of variables during the latter half; and (3) the retardation of growth for long

[1] These studies have been made possible through research grants from Mrs. Harry Snyder of Minneapolis, the Rockefeller Foundation, the Macy Foundation as well as those from the Federal and N. Y. State research appropriations. Some of the many researchers who have contributed their efforts to these studies are: Professor S. A. Asdell, Prof. L. L. Barnes, Dr. G. H. Ellis, Prof. A. B. Hastings, Dr. O. Lowry, Prof. L. A. Maynard, Dr. W. L. Nelson, Dr. Mary Crowell Paul, Dr. John Saxton, Dr. C. A. H. Smith, Miss G. Sperling and Mrs. L. Clise Will.

periods by feeding diets qualitatively adequate but deficient in energy sources.

DIETS OF UNIFORM COMPOSITION FED THROUGHOUT LIFE

One of the earlier studies in feeding diets throughout life was made to evaluate two different levels of cellulose in the diet (6). Previously the upper level of cellulose that was considered suitable for species such as the rat or pig was 10%. Preliminary work indicated as much as 20% of regenerated cellulose could be fed without injury during the growing period. Finally small groups of male rats were maintained until they died upon two synthetic diets containing respectively ten and twenty per cent of cellulose. The mean length of life for these two groups was 674 ± 35 and 602 ± 61 days, respectively. Upon our stock diet at that time the mean length of life was 503 ± 12 days.

These data indicated a possible favorable effect of a diet containing a considerable amount of inert material such as cellulose. Since this experiment was concluded a decade ago, much knowledge has been gained concerning both the requirement of the rat for vitamins and the adsorption of these factors upon inert materials. The time now is probably ripe for extending this type of study inasmuch as the inert portion of the diet plays an important role in the regulation of excretion. This in turn may be of importance in ageing since the problem of constipation seems to be a major one in man during the latter half of life—even during the whole of life for some people.

The latest experiment of this type in which the same diet is fed throughout life, and which has been in operation nearly three years, was started in March, 1939. The purpose in this case was to test the old thesis, "Eat what you should and after that you may eat what you will."

Two hundred rats were placed upon a basal diet of starch 20, cellulose 2, cod liver oil 8, lard 7, sucrose 5, alfalfa leaf meal 1, salt mixture 6, dry yeast 14, casein 27 and dry liver 10. Each rat was allowed the same weight of this basal diet per day in an amount calculated to be adequate for growth if supplemented with some form of calories. The diet was very rich in vitamins, minerals and protein.

The rats were then divided for purposes of supplying adequate energy into four groups, supplied with supplements as follows:

1. Lard 10 parts, cooked corn starch 90 parts.
2. Lard 10 parts, cooked corn starch 50 parts, sucrose 40 parts.
3. Lard 10 parts, cooked corn starch 60 parts, dried whole milk 30 parts.
4. Lard 10 parts, cooked corn starch 60 parts, dried pork liver 30 parts.

The question asked, in terms of human nutrition, might be stated as follows: "If a person eats an adequate basal diet, does it matter whether he chooses additional calories in the form of (1) starch, (2) starch and sugar, (3) starch and whole milk, or (4) starch and meat?"

This study is near enough its end to justify some scrutiny of the results. If one assumes that the six animals that remain alive today are dead the results concerning the mean span of life would appear as shown in Table 1.

TABLE 1

The effect of supplements to an adequate basal diet upon the mean span of life

Dietary variable	Mean life span in days	
	Males	Females
1. Starch	595	705
2. Sucrose	674	717
3. Milk	688	610
4. Liver	531	682

These data indicate that there is no benefit as far as the span of life is concerned in supplementing an adequate diet with even the best of natural foods such as liver and milk.

In the second place it is evident that the female rat tends to outlive the male and thus presents the same enigma as in the case of man. This has been observed quite consistently in studies with rats, and has been long known in the case of man. The common explanation in the case of human beings is that the male is more exposed to industrial hazards. This is certainly not the case in the rat since food and environment are the same for both sexes in such experiments. A century ago Edmonds (7) explained the difference on the basis of the greater tendency of the male to worry. No means of measuring this have been devised for rats.

In the course of this study a few of the rats were killed at regular intervals in order to follow the

trend of chronic diseases. At the end of about 300 days it was found that the basal diet did not supply enough vitamin E in the case of those fed rich carbohydrate diets because few viable sperm were found in the males of groups 1 and 2. On the other hand, the other two groups fed supplements of meat and milk were producing viable sperm in their second year of life. A new experiment was run parallel with this one to make sure that vitamin E was the deficiency and this proved to be the case.

This indicates that there is no correlation between the span of life of a male rat and the age at which it ceases to produce viable sperm. This suggests that a diet may be adequate in terms of the total span of life but deficient as far as life activities are concerned. As Stieglitz has stressed (8), the purpose of research in geriatrics, the science of all ageing, is to "put more life into the years rather than more years into life."

In this experiment rats were allowed to become as fat as each individual desired. This is what really happens in a large group of human beings although very different factors determine how fat each individual becomes. It has long been recognized in animal husbandry that certain individuals are "poor feeders" or "expensive keepers." Thus a ewe may eat much but not fatten, or a horse may require more feed to maintain its weight than another of the same size.

In any group of rats there are individuals that never fatten and others that fatten excessively. If a spot diagram is prepared in order to determine the relation between the maximum weight attained by an individual, and the length of life, the spots assume the shape of a triangle.

The maximum length of life falls to those rats whose maximum body weight at any period of life is intermediate between the possible extremes. The short-lived rats fall in those groups that are unable to fatten and in those that fatten excessively. This has been reported from similar, earlier studies in which rats were allowed to ingest all the food desired.

DIETARY VARIABLES INTRODUCED DURING THE LATTER HALF OF LIFE

Several experiments have been completed in which the variables were not introduced until middle life. Most of us arrive at middle age before we realize that there is a latter half of life with many special problems.

In such a study, rats are kept until about one year of age upon a stock diet. When the life span is about half finished variables can be introduced after dividing the animals into groups. During the past ten years, five experiments of this type have been completed. The four early ones were all attempts to evaluate the effect of different levels of protein upon the span of life. The results need not be discussed in detail since they were negative. The level of protein in the diet of the rat during the latter half of its life seems of minor importance. In such rats the non protein nitrogen of the blood of animals fed diets rich in protein is significantly higher than those fed lower levels. However, the state of the lungs rather than that of the kidneys seems to be the determining factor in establishing the length of life of the rat. As others have shown, the kidneys of rats fed high protein diets hypertrophy, but this does not seem to shorten the life span.

The last study in this series involving the latter half of life contained sixteen experimental groups, as shown in Table 2. A total of 329 male rats was used. The design in this case was such that it permitted a combination of groups in evaluating the data. Thus the eight groups fed high protein diets could be compared with the same number fed low ones. The effect of running rats in a rotary cage could be determined by comparison with those given no exercise. Details of this study have been reported elsewhere (9), but can be summarized briefly.

From this study of the sixteen groups, the group with the greatest life span was given exercise, fed a low protein diet with liver as the source of protein. Members of half the groups were not allowed to fatten excessively. In general the dominant factor in this study proved to be the degree of body fatness. Groups kept from becoming excessively fat either by means of exercise or the restriction of calories were consistently the long lived groups.

Two hundred and fifteen of these rats were studied carefully after death. The results have been summarized recently by Saxton and Kimball (10). A few quotations from their summary may be enlightening:

"The most common diseases encountered were in order of frequency: chronic pneumonia with bronchiectasis; chronic nephrosis characterized by parenchymatous degeneration following obstruction of renal units by albuminous casts; various types of tumors, a large part of them diagnosed as lymphosarcoma, arising within the lungs." "The

frequency of chronic pneumonia and of tumors bore no direct relation to modifications of diet during the latter half of life, although some of these modifications altered significantly the average life span." Furthermore Saxton found the frequency of chronic nephrosis was greater in animals fed the higher protein diets, in animals fed liver in contrast to casein, in animals allowed to fatten in contrast to those kept underweight.

The calcification of the organs of these rats has been described by Barnes (11). In general he has found increasing calcification of the heart, with age in these rats. Variables introduced in the study, however, such as exercise and degree of body fatness seemed to modify this calcification. Thus rats prevented from becoming excessively fat and forced to exercise seemed to have less calcification of the heart. Even such factors as the form in which calcium was given in the diet seemed important and must be given more attention in future work. Considerable calcification of the spermatic artery, such as that described by Willens and Sproul has been observed in male rats after middle life. It is still uncertain if the incidence of this calcification increases progressively with age (12).

In general these experiments concerning the latter half of life indicate that diet during this period has a marked influence both upon the total span of life and upon the diseases that develop in the course of ageing.

Stephenson and others (13) have found that the supplementing of the diets of human senile patients, with vitamin C, dried yeast and other of the B vitamins, may improve some conditions such as constipation in spite of any indication of retarding ageing itself. However, their studies only covered a period of one year which would be equivalent to about 10 days in the life of a rat. If such results can be obtained with patients in such a relatively short period, it is not surprising that the rat should respond to variables introduced in middle age.

TABLE 2

Regimens of the Sixteen Experimental Groups

Group 1.	High protein	casein	exercise	restricted diet
Group 2.	High protein	casein	exercise	unrestricted diet
Group 3.	High protein	casein	no exercise	restricted diet
Group 4.	High protein	casein	no exercise	unrestricted diet
Group 5.	High protein	liver	exercise	restricted diet
Group 6.	High protein	liver	exercise	unrestricted diet
Group 7.	High protein	liver	no exercise	restricted diet
Group 8.	High protein	liver	no exercise	unrestricted diet
Group 9.	Low protein	casein	exercise	restricted diet
Group 10.	Low protein	casein	exercise	unrestricted diet
Group 11.	Low protein	casein	no exercise	restricted diet
Group 12.	Low protein	casein	no exercise	unrestricted diet
Group 13.	Low protein	liver	exercise	restricted diet
Group 14.	Low protein	liver	exercise	unrestricted diet
Group 15.	Low protein	liver	no exercise	restricted diet
Group 16.	Low protein	liver	no exercise	unrestricted diet

THE RETARDATION OF THE GROWTH RATE BY INSUFFICIENT CALORIES AND ITS EFFECT UPON LIFE SPAN AND THE DISEASES OF OLD AGE

A century has passed since Edwin Chadwick and William Farr discovered that the overfeeding of prisoners resulted in a higher mortality rate and a greater incidence of disease (14). An almost forgotten contemporary of Chadwick is T. R. Edmonds, mentioned before. His work entitled "Life Tables Founded upon the Discovery of a Numerical Law Regulating the Existence of Every Human Being, Illustrated by a New Theory of the Causes Producing Health and Longevity" was published in London in 1832 (7). Edmonds believed that the circumstances most favorable to vitality consisted in alteration of privation and saturation. He believed that saturation impaired health more than privation. Of course, Cornaro (1464–1566) and many others had preached this doctrine earlier (15).

Jackson has provided excellent reviews of the experimental literature concerning inanition (16). The late Professors Osborne and Mendel became

interested about 1911 in the resumption of growth in rats after periods of retardation due to feeding diets deficient in proteins or vitamins. In 1917 they reported that rats could not only retain their power to grow after as much as 552 days of retardation but the females retained their powers of reproduction later in life (17).

In a series of experiments started in 1927 with brook trout, we found that this species was able to resume growth after a long period of retardation (18). If the trout-diet lacked certain essentials, those groups that were retarded in growth might live six months or more while those that grew normally tended to perish in the course of about three months.

The possibility existed that the rate of growth might have a profound influence upon the span of life. Any factor that modified the span of life might be expected to operate through its effect upon the diseases of old age.

Many deficiencies in the diet can retard the growth of an animal. The one employed in all of the studies at Cornell involves a restriction of calories. This is readily accomplished by feeding a diet that has a high per cent of protein, vitamins and inorganic elements but allowing an animal to ingest only a limited amount of this diet. Thus an animal has the option of growing and then dying because it lacks enough calories to maintain its body temperature, or of maintaining life at a constant body weight. It selects life.

Three studies in retarded growth with white rats have been undertaken. Two have been completed and one is ending its third year. The major questions that have been asked in these studies are the following:

How long can a rat be retarded in growth and still retain its ability to grow?

What is the effect of retarded growth upon the mean span of life?

What is the effect of the retardation of growth upon the ultimate body size?

Does the retardation of growth modify the incidence of any given disease at a given age?

Such experiments must be in operation about four years. In our first study (19) the oldest rat attained an age of 1,421 days. Although the first trial involved only 106 rats, divided into three groups, it indicated that rats retarded in growth lived longer than animals allowed to attain maturity at a normal rate. Furthermore rats were retarded in one group for 911 days and were still able to resume growth when allowed enough calories in their diet. The conclusions from this first experiment reported in 1934 have been verified and extended in the two more extensive studies that followed.

Several questions arose from this first study. In the first place, our temperature regulation in our animal room failed twice, allowing the room to become too hot and resulting in the loss of some of the animals that were retarded in growth. These were too deficient in reserve calories to allow for an increase in body temperature with the consumption of more fuel from tissues. At first thought it might seem that this increase in room temperature had left only the hardy survivors among the retarded and that these continued to a ripe old age. This was not the case. A later experiment with animals growing normally was almost completely lost due to the failure of the temperature regulator and the killing of a large group of normal animals. The residue that lived through this catastrophe exhibited only the mean span of life found in our colony fed the stock diet. Hence there is no evidence that selection for a long life can be made by exposing groups to a high temperature.

A second possibility was that the control group had been overfed and hence died prematurely. This was probably partly true and is true for every experiment of this type in which the animal is allowed all the food it desires. However, the extension of the extreme span of life in the case of the survivors of the retarded growth groups was so great that it exceeded the bounds of any normally fed group of animals, either in our own laboratory or in the extensive series of studies by Sherman (2) and Drummond (4). The survival of individuals of extreme age from a total of 70 retarded rats was greater than might be anticipated from many thousands of normal ones in our laboratory or in those cited above.[2]

The second and third studies of retarded growth were modified in one way. In the first study the rats that grew normally were allowed to consume more of the same diet that was given in limited amount to the retarded animals. Thus, those that grew normally in the first study ingested more pro-

[2] Dr. E. J. Farris has informed me privately that he now has a strain of rats at the Wistar Institute in which about ten per cent can attain an age of three years when reared normally. He records one rat that survived for 1,415 days, or nearly as long as the best of the retarded animals.

tein, vitamins and inorganic elements per day than the retarded animals.

In the second and third trials both the normal and retarded animals were given the same daily allowance of the basal diets. In addition the animals allowed to grow were given supplements of calories in the form of starch, sugar, fat, etc., as indicated in Table 1. These animals described previously in connection with Table 1 served as the controls in the third retarded growth study.

In the second study (20), the results were essentially the same as in the first. Different groups of rats were retarded for periods varying from 300 to 1,000 days. There were individuals alive in all retarded groups when the last of the controls had died. The group retarded for 1,000 days had only a few members left when it attained this age. Some evidence indicated that the power of growth at this age had been lost because only part could resume growth. The ultimate body size was progressively less the longer the period of retardation. Thus the length of the tibia was 4.1 mm. in the normal male and 3.6 mm. in those retarded for 700 days. The permanent stunting of the female was less.

In this second study some attention was given to the diseases that developed. Tumors were absent during the time of retardation even though there was a normal incidence during this same period in the normal animals. About a fourth of the teeth of the animals at the time of death were carious or missing, from the observations of Dr. Smith (21). Some evidence also indicated that the retarded animals were less subject to lung diseases than the normals of the same age. Great deposition of calcium occurred in the eyes of rats, especially after they reached an age of 900 days. In one case over one per cent of Ca was found in the eye after drying.

In the second study of retarded growth considerable attention was given both to the calcification of the costal cartilages as the animals aged and to the calcification of the tissues found in post mortem examination. Both X-ray photographs and histological methods were used in the study of this calcification. As one might expect, the retarded animals exhibited a slower rate of calcification of the costal cartilage. Quite the contrary was the case, however, in regard to the calcification found in the aorta. At the same age the retarded animals had a much higher incidence of calcification of this organ (22). Photographs have been published to illustrate this.

This calcification of the aorta has not been observed to any extent among the retarded animals in the third experiment which is still in progress. The diets used in the third and second experiment were slightly different. These differences can be noted in Table 3.

From observation and a review of the literature one might expect diet 3 to promote calcification more than No. 2, since it undoubtedly contains more sterols with its higher levels of yeast and liver. Quite the opposite seems true. Possibly the diet has no relation to this calcification in retarded animals and some variable that we do not recognize has come into play.

TABLE 3

Composition of diets used in the retarded growth studies

Constituent	Study No. 2	Study No. 3
Cooked starch	22	20
Regenerated cellulose	2	2
Lard	10	7
Sucrose	10	5
Salt Mixture (O. and M.)	6	6
Cottonseed oil	5	
Yeast	5	14
Casein	40	27
Dry liver		10
Cod liver oil	Fed separately	8
Alfalfa leaf meal		1

At least the second study indicated that retarded animals were able to outlive the normal ones in spite of suffering from calcification of some organs.

THIRD STUDY OF RETARDED GROWTH

The third experiment in retarded growth which is now progressing near the end of its third year was designed to answer three questions:

1. To what extent are the diseases of old age held in abeyance to a later date?
2. What distinguishes the physiological-biochemical state of the body of the retarded rat from that of the normal of the same age?
3. How long can the rat be retarded and still resume its normal growth rate after realimentation?

Five hundred rats were started in this study in order that representatives from each group might

be killed at hundred day intervals to furnish material for the pathologist and biochemist and still leave a sufficient number for life span studies. Three hundred of these rats were retarded in growth and 200 were allowed to grow normally as outlined in Table 1.

After this experiment had been in operation 1,000 days only 10% of the normal animals were alive while 40% of the retarded ones had survived. Those killed are excluded from these data. Typical of the usual results was the sex distribution among the survivors. The numbers were about equal among the retarded animals but only females were alive in the normal groups after 1,000 days.

The pathological findings will be published at a later date by Dr. Saxton in extension of his preliminary report (23). However, the picture is clear from work upon the animals that were killed. At a given age the incidence of diseases of the middle ear and lungs of retarded animals is much lower than in animals that have grown normally. Furthermore the third study has confirmed the observation made in the second, that tumors are rare among retarded animals during the period of retardation. They seem to become subject to them only after complete realimentation, and attainment of ultimate body size (23).

In their histochemical studies Doctors Lowry and Hastings found the skeletal muscles of the retarded animals contained more chlorides, water, total phosphorus and potassium than the controls (24). They interpret this as "a youthful proportion of fibers and extracellular tissue" in the retarded animals.

As far as the composition of the entire body is concerned, Dr. W. L. Nelson found the chief characteristic of the retarded body was its high ash and low fat content (25). In both the second and third study of retarded growth it was found that some systems such as the bones continue to grow very slowly even when the weight of the entire body is held constant. Nelson, from chemical analyses, concluded there were three stages in this growth. In the first the skeleton gained at the expense of other organs; in the second the proportions of the body were well maintained. In the third, the type was that of late adolescence in which the per cent of protein and fat increases.

In these studies of retarded growth where the rat body is only allowed to increase slightly, about 5 grams every fifty days, one is struck by the ability of the bones to continue growth. Even when the body is kept at constant weight for a period of fifty days the bones continue to grow slightly. The bones seem to have the greatest growth potential of any part of the body. Since the body weight is held constant for long periods while the bones grow somewhat, this growth must be at the expense of other organs. Furthermore, the bones decalcify as ageing proceeds at a rate that seems to be little modified by the retardation of growth. At extreme ages severe decalcification is found in these bones.

In all our studies the only one in which we have been able to develop a superior bone from the point of view of breaking strength was in an experiment described by Asdell and others (26). In studying the breaking strength of bones, Miss S. Chen (27) found that among a number of experimental groups the only significant difference was in female rats that had passed through a series of gestation periods with the young killed at birth. Thus the female seems to create a superior bone in preparation for the drain that comes in lactation. This is only a modifying factor that enters in the course of ageing, and probably falls in the domain of endocrinology rather than nutrition.

Various attempts have been made to determine if the extension of the life span by the retardation of growth can be accounted for in other ways than in the later appearance of the chronic diseases of adult life. Three such studies will be described briefly.

From time to time studies have been made of the blood. Results in the field of chemistry have been negative. The number of erythrocytes is normal for retarded animals except at about 150 days of age the number is significantly higher than the control group. The leucocytes afford quite a different picture, however. Until about 600 days of age the mean white cell count for retarded animals varies from 4.6 to 6.5 thousands while the values for the control animals during this same period vary from 8.5 to 9.6. After this 600 day period the values for the retarded animals become normal at the higher level. The same results were obtained in both our second and third studies of retarded growth although they were made with different groups of rats and separated by a time interval of about four years. Mrs. L. C. Will has made differential counts upon many of these blood samples but details cannot be described here.

Electrocardiograms have been made upon normal and retarded rats but have indicated no differences except that the heart rate is about 455 for the normal control rat and 355 for the retarded.

From time to time the question of differences in basal metabolism between normal and retarded animals has arisen. This is part of the larger question concerning changes in basal metabolism in the course of ageing. Black (28) made preliminary determinations upon some of our rats that were 700 days old and from normal groups. He found values somewhat higher than for animals a third as old.

Mrs. L. C. Will has given much attention to the basal metabolism of both retarded and normal animals with the surprising result that there is relatively little difference. The retarded animals have slightly lower basal metabolic rates but the difference on the basis of body surface is only about 5%. There is great individual variation.

In closing one may anticipate a question commonly asked concerning the happiness of retarded animals. As biochemsts we have no quantitative methods for "happiness." Retarded rats are alert and active even after long periods of retardation. However, one can form some judgement of the happiness of a dog. Since last July two half-breed dogs of a Cairn-Scottish terrier cross have been retarded in growth starting at an age of three months. Anyone who observes these retarded dogs, either in their pens or while on walks through the woods, will be convinced that they are about the happiest of animals. For them life is full of interest and they have the greatest zest for discovering any possible morsel of food that is prohibited in the experiment. These pups even have pleasures unknown to ordinary dogs. Whereas the dog fed normally will refuse to eat the flesh of another dog, these retarded ones take the greatest pleasure in cannibalism. One instinct overcomes another.

SUMMARY

The diet exercises a profound influence upon the length of life. Part of this influence is due to modification of the chronic diseases that become important during the latter half of life. Three methods of attack have been used in relating dietary variables to changes during ageing, namely, the feeding of a constant diet from weaning until death, the maintenance of animals under fixed conditions with the introduction of variables in middle life and finally the retardation of growth during long intervals of time thus delaying the attainment of maturity.

Of variables such as the level of protein, the degree of body fatness and the amount of exercise taken during the latter half of life, the fatness of the body seems to be the dominating one. A high protein level in the diet may cause more injury to the kidneys than a low one, without shortening the span of life. Keeping the body from becoming too fat, either through limitation of calories ingested or by means of exercise, seems the most important.

The life span of rats is foreshortened either by excessive fatness of the body or the inability of the body to achieve an optimum weight. Under most conditions, female rats live longer than males. This is a sex difference. Reasons given for this in the case of man, such as the greater exposure of the male to industrial hazards, cannot apply in the case of experimental animals living under the same conditions.

As the rat ages the lungs seem to be the most vulnerable to the attacks of disease, although no specific organism seems responsible. The study of the effect of diets during the whole of the life span of experimental animals such as the rat affords a promising technique for a combination of the disciplines of the pathologist and nutritionist in attacking the diseases common in ageing.

The retardation of the growth of rats can be extended for periods far greater than the normal span of life. Even after 1,000 days of retardation, rats can resume growth and attain a body size about ten per cent smaller than normal. The expectancy of life of retarded rats is greater than that obtained by any other means. The retardation of growth in rats by diets deficient only in calories results in the postponement of the disease of the lungs and the development of tumors to a later period in life. Tumors seldom appear during the period of growth retardation when insufficient calories are allowed for growth.

During the first 600 days of retardation the leucocyte count is about two-thirds that of the normal. The pulse rate is about 100 below the normal. The basal metabolism of retarded rats is only slightly lower than the normal. The chemical composition of the body of a retarded rat resembles that of a young one. Relatively small changes in the diet in the course of two studies of retardation have exercised a profound influence upon the calcification of tissues, especially the aorta. This may afford a method for studying the dietary factors important in calcification of tissues.

No one knows the possible extension of the life span of any species.

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Origin, Nature and Properties of Gramicidin and Tyrocidine*

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PRODUCTION OF ANTIBACTERIAL SUBSTANCES BY AEROBIC SPORULATING BACILLI

IN ONE of his early publications on the etiology of anthrax, Pasteur reported that the injection of *Bacillus anthracis* into susceptible animals often failed to produce the disease if the bacterial suspension was contaminated with "common bacteria"; he suggested that this observation could "perhaps justify great hopes from a therapeutic point of view" (1). The phenomenon of microbial antagonism has since been observed a great many times in practically all groups of microbial species, and several attempts have been made to make use of it in therapy (2, 3). Of direct interest in the present discussion are the several reports dealing with the antagonistic action exerted by certain cultures of sporulating aerobic bacilli. Organisms described under the names of *Tyrothrix sp.*, *Bacillus mycoides*, *Bacillus subtilis*, *Bacillus mesentericus*, etc., have been found to exert bacteriostatic, bactericidal and lytic effects on a variety of unrelated bacterial species, and to release into the medium soluble principles endowed with these antagonistic properties.

It may be of some interest to state briefly the origin of the studies to be described in the present report; they were not concerned with the general phenomenon of bacterial antagonism, but aimed specifically at the preparation of bacterial enzymes capable of attacking the Gram positive structure of pyogenic cocci. Two assumptions formed the basis of this venture: (*a*) that one can find in nature microorganisms capable of performing almost every conceivable type of biochemical reaction through the agency of selective enzymes (4), (*b*) that Gram positive bacteria exhibit a certain similarity in cellular structure, and in particular possess a cell wall of related composition which determines their reaction to the Gram stain. In an attempt to isolate microorganisms capable of attacking this hypothetical Gram positive cell wall, suspensions of living streptococci and staphylococci were added to soil in the hope that there would develop in these soil preparations a microbial flora capable of attacking the Gram positive cocci. There was thus isolated from soil a culture of an aerobic sporulating bacillus—a strain of *Bacillus brevis*—which causes the destruction of living cells of Gram positive organisms both *in vitro* and *in vivo*; it soon became obvious, however, that *Bacillus brevis* owes its antagonistic activity not to the activity of an enzyme selectively directed against the Gram positive structure, but rather to the production of a toxic principle which causes the death of the susceptible bacterial cells (5, 6, 7, 8, 9). Before describing the nature and properties of this toxic principle, it is worth recording that different strains of *Bacillus brevis* endowed in varying degree with the same type of antagonistic activity have now been isolated from several natural sources (soil, sewage, cheese) (9, 10, 11); it is also certain that other species of aerobic sporulating bacilli are also capable of producing antibacterial substances (13, 14, 15, 16, 17, 17a, 18, 19, 20). Organisms of the *Tyrothrix* group, among which this property was recognized very early, have now been found to be strains of *Bacillus subtilis* (9, 15, 16, 17).

SEPARATION OF ANTIBACTERIAL SUBSTANCES FROM CULTURES OF BACILLUS BREVIS

The antibacterial agent produced by *Bacillus brevis* is abundantly formed when the organism is grown under aerobic conditions in peptone or gelatin media. From autolyzed cultures, it is possible to obtain in solution several active fractions which differ, not only in chemical composition, but also in antibacterial and other biological properties. These different fractions all appear to be breakdown products of a common mother substance, present in the bacterial cell, and to result from the autolytic process and from the manipulations inherent in the techniques of extraction and purification.

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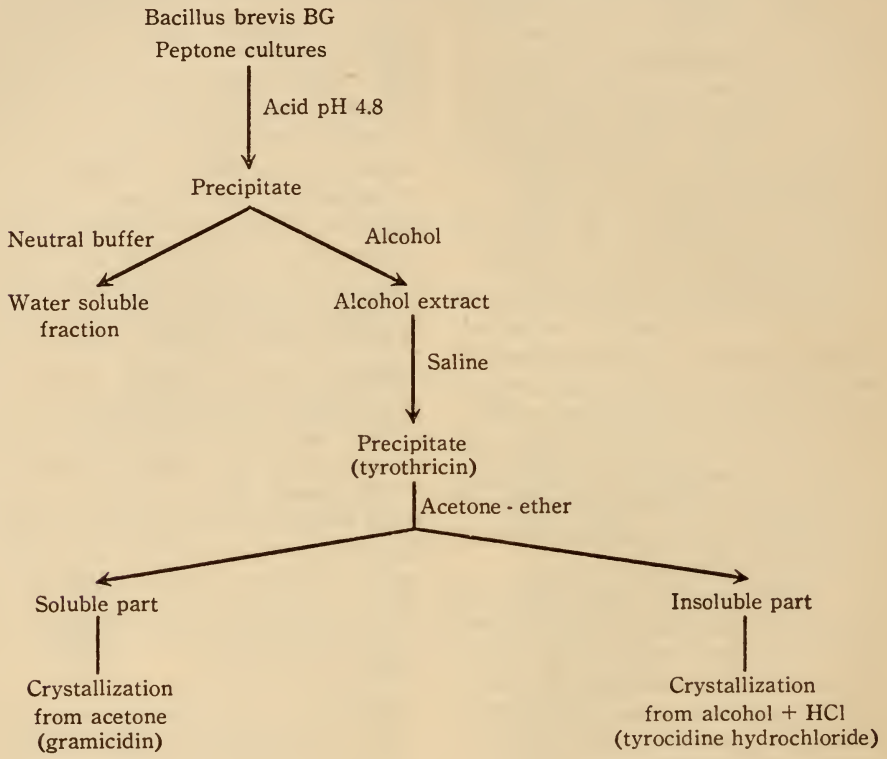
Acidification of the autolyzed culture of *Bacillus brevis* (after 72–96 hours incubation at 37°C.) gives a precipitate from which an antibacterial principle can be obtained in solution by extracting with neutral buffer. This water soluble material is protein in nature. On treatment with acid alcohol or acetone, it yields an inactive precipitate (a protein) and an active fraction which is soluble in these organic solvents, but insoluble in aqueous media. The active, water insoluble material can also be separated by treating the water soluble complex with proteolytic enzymes (trypsin, papain, pepsin) which destroy the protein component and set free the active material (8, 9).

The alcohol soluble, water insoluble fraction has been called tyrothricin to recall the generic name *Tyrothrix* (name of a group of aerobic sporulating bacilli which, as stated above, was early recognized to have antibacterial activity). Tyrothricin can be conveniently produced by precipitating the whole autolyzed culture of *Bacillus brevis* with hydrochloric acid at *p*H 4.7, extracting the precipitate with 95 per cent alcohol, separating the active alcohol soluble fraction by filtration or centrifugation and precipitating from it the active material by diluting with 10 volumes of 1 per cent sodium chloride. The yields of tyrothricin are unexpectedly large; from 1 liter of culture of *Bacillus brevis*, one can obtain 500 mg. or more of tyrothricin. The tyrothricin fraction has yielded two active components, gramicidin and tyrocidine, which have been obtained in the crystalline form, and which account for a large percentage of the total mixture. Although the relative proportions of the two components probably vary from batch to batch, it appears that in general gramicidin and tyrocidine account approximately for 20 and 50 per cent of the total weight of tyrothricin. Gramicidin and tyrocidine can be separated and crystallized by making use of their differential solubilities in acetone and ether and in particular of the fact that the salt tyrocidine hydrochloride is considerably less soluble than the neutral gramicidin in mixtures containing ether (21, 22, 23).

TABLE I
Preparation of Tyrothricin, Gramicidin, and Tyrocidine



THE NATURE OF GRAMICIDIN AND TYROCIDINE

Both gramicidin and tyrocidine are found to be complex polypeptides, rich in nitrogen, hydrolyzable by acids but not by ordinary proteolytic enzymes. Gramicidin, having more unusual and interesting biological and chemical properties than tyrocidine, has been the more thoroughly studied (22, 24, 25, 26).

Gramicidin, although composed of amino acids, possesses no free carboxyl or amino groups. This may mean that "end" groups are combined as ester or amide derivatives or else with each other to form a large cyclic peptide. In the intact molecule there seems to be a free hydroxyl group. After acid hydrolysis this is found in a 1-amino-2-hydroxy compound which is not a β-hydroxy-α-amino acid of the sort found in proteins. The other hydrolytic fragments are known α-amino acids: tryptophane, leucine, valine and alanine (24). Interestingly enough, these do not all have the *l*-configuration as they do in other natural products. All of the leucine and one half of the valine are recovered as the "unnatural," or *d*- optical isomers (27).

Fig. 1. Photomicrograph of Crystals of Gramicidin. ×225

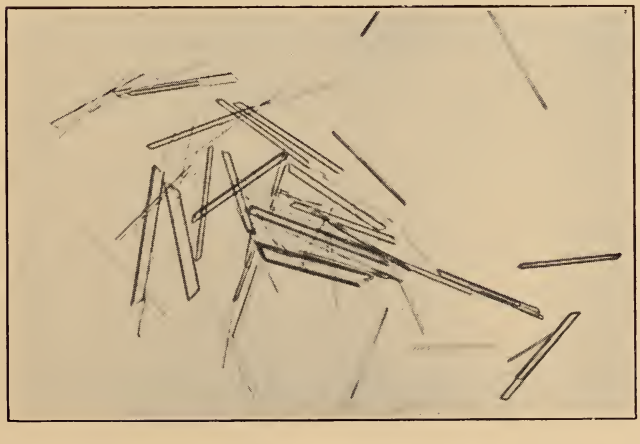


Fig. 2. Photomicrograph of Crystals of Tyrocidine Hydrochloride. ×320

Quantitative data, as yet incomplete, give evidence of the probable molecular size and composition of gramicidin. Cryoscopy, analysis and vapor pressure equilibration have suggested values for the molecular weight ranging from 600 to 3100 (26). Cryoscopy of camphor solutions together with tryptophane and hydroxyl group determinations have favored molecular weights of either

about 1100 or 1500. Several possible empirical formulas can be proposed; a satisfactory one is $C_{74}H_{105}N_{15}O_{13}$ (mol. wt. 1413). The molecule of this size would have three residues each of *l*-tryptophane, *l*-alanine and *d*-leucine, and one each of *l*-valine, *d*-valine and of the aminohydroxy constituent (24). The exact nature of this latter substance, and the arrangement of the components in the peptide chain, remain to be ascertained.

Tyrocidine is a basic polypeptide crystallizing as the hydrochloride. Recognized hydrolytic products are: ammonia, tryptophane, tyrosine, dicarboxylic amino acids, basic amino acids (24, 25), alanine and phenylalanine (25). As is the case with gramicidin, here too certain of these amino acids possess the unnatural *d*-configuration (27). Although, in contrast with gramicidin, tyrocidine contains many amino acids suitable for quantitative estimation, complete analyses have not been made as yet. The preliminary results indicate a unit having the approximate formula $C_{126}H_{166}N_{26}O_{26} \cdot 2HCl$ (mol. wt. 2534) or possibly a unit of one-half this size (24). Such a unit might have four residues each of phenylalanine and dicarboxylic amino acid (in part aspartic acid; three or four are combined with ammonia as neutral amides) and two each of alanine, tryptophane, tyrosine and basic amino acid (probably lysine).

PHYSICOCHEMICAL PROPERTIES OF GRAMICIDIN AND TYROCIDINE

The lack of solubility of the two substances in aqueous media, and their high solubility in alcohols, acetone, dioxane, may be due in part to their high content of amino acids with low solubility in water, and to the paucity of ionizing groups. Tyrocidine which does possess a small number of ionizing groups has the greater solubility in water and lesser solubility in ether that would be predicted from its composition. Tyrothricin, tyrocidine, and to a smaller extent gramicidin give fairly stable colloidal emulsions in distilled water, or in glucose and glycerine solutions, in the absence of electrolytes. Addition to the systems of certain substances capable of markedly depressing surface tension (bile and synthetic detergents for instance) permit the preparation of well dispersed colloidal solutions which remain stable even in the presence of electrolytes. Both gramicidin and, especially, tyrocidine behave themselves as surface active substances (28); in fact, the presence of tyrocidine in the mixture tyrothricin increases appreciably the stability of emulsions of gramicidin.

The surface activity of tyrocidine appears to be of special importance in explaining its biological activity; from the physicochemical point of view, the substance behaves as a cationic detergent and, as will be shown later, it exhibits the toxic properties of this class of compounds. Like some cationic detergents tyrocidine also behaves as a protein precipitant, a property which may be concerned in its biological activity.

Both gramicidin and tyrocidine are resistant to proteolytic enzymes, perhaps as a result of the presence of *d*-amino acids in the peptide chain (27). Both substances are also extremely stable in alcoholic solutions even when maintained at high temperatures for long periods of time. It has been frequently observed that dilute aqueous solutions of gramicidin or tyrothricin lose their *in vivo* activity, slowly at room temperature, rapidly when heated. It is now recognized that this change of activity is not due to a destruction of the substance, but rather to its precipitation from the colloidal solution. Gramicidin boiled in water for several hours, or autoclaved at 120°C. for 15 minutes at acid, neutral and alkaline reactions, can be recovered in an active form by rendering it soluble with alcohol, or with surface active substances like lauryl sulfate (Duponal). It appears therefore that gramicidin is very stable to heat, not only in alcohol, but also in aqueous media.

BIOLOGICAL ACTIVITY OF GRAMICIDIN AND TYROCIDINE

In spite of their common origin, and of the fact that both substances are polypeptides, and both behave as surface active agents, gramicidin and tyrocidine differ not only in other chemical properties, but also in biological activity. Both substances, when added to culture media in amounts of the order of fractions of μg per cc. of fluid, will prevent or retard the growth of most species of Gram positive bacteria. Tyrocidine added to bacterial cells resuspended in buffer solutions in the absence of serum, tissue extracts, or peptones, exerts a marked bactericidal effect on both Gram positive and Gram negative species (9). Gramicidin, on the contrary, is completely inactive against Gram negative bacilli, moderately active against meningococci and gonococci, and inhibitory

to practically all Gram positive bacterial species so far tested (with the exception of acid fast bacilli) (9, 29). Mention must be made that one can isolate from susceptible bacterial species, variant forms which are more resistant to gramicidin and which remain resistant even after repeated subcultures in media free of the substance; these resistant forms are very readily obtained from staphylococcus cultures, but with difficulty from group A streptococci.

It is of special interest that gramicidin is primarily a bacteriostatic agent, as is well illustrated by a study of its effect on group D streptococci. The growth of these organisms is, on the one hand, inhibited by the presence of small amounts of gramicidin in the culture medium; on the other hand, streptococci of the same species resuspended in aqueous media with very much larger concentrations of gramicidin, remain viable as long as the controls kept in water at the same temperature and *p*H.

Gramicidin never causes the lysis even of the most susceptible organisms. Tyrocidine on the contrary lyses many bacterial species. There is good evidence, however, that this lytic effect is not a direct one, but only a secondary autolytic process which follows upon the death of the cell and which occurs only in species endowed with active autolytic enzymes (pneumococcus and staphylococcus for instance) (9).

Tissue culture experiments reveal that, in concentrations adequate to check bacterial growth, gramicidin and tyrocidine do not exert any obvious toxic effect on white blood cells (30). Even high concentrations of gramicidin (0.5 mg./cc.) do not affect the oxygen uptake of polymorphonuclear cells (prepared from rabbit and mouse peritoneal exudates) resuspended in Ringer glucose solution. Similar concentrations of tyrocidine, on the other hand, cause the cessation of respiration and the disintegration of white cells in the same systems.

Both gramicidin and tyrocidine act as hemolytic agents for mammalian red cells, but the hemolytic process is of a different nature in the two cases. The hemolytic effect of gramicidin requires several hours to become manifest, even though very small amounts of the substance are sufficient to elicit it; it is completely inhibited by 1 per cent glucose or manitol. Tyrocidine, on the contrary, causes immediate hemolysis irrespective of the presence of glucose in the system (9, 31, 32).

Spermatozoa are also extremely susceptible to gramicidin; concentration of 0.00001 per cent being sufficient to modify their metabolism and destroy their motility (33).

The differential susceptibility of animal cells to gramicidin and tyrocidine is well illustrated by the behavior of frog eggs. Eggs exposed to small quantities (50 mg. per cc. or more) of tyrocidine were quickly killed; eggs in even higher concentrations of gramicidin continued to develop and became swimming tadpoles, although unobserved abnormalities may have been produced.

MODE OF ACTION OF GRAMICIDIN AND TYROCIDINE

The strikingly different reactions of living cells to gramicidin and tyrocidine suggests that the two substances exert their biological effects through profoundly different mechanisms. Although the nature of these mechanisms has not been elucidated, some biochemical reactions which they determine have been recognized.

When a proper amount of tyrocidine is added to a cell suspension (for instance a few μg per cc. of bacterial culture) there is observed an immediate and irreversible cessation of metabolism (as measured by oxygen uptake, reduction of methylene blue or of ferric ion, acid production); as already stated, the inhibition of metabolism is often accompanied by a rapid disintegration and lysis of the affected cells (pneumococci, staphylococci, protozoa, polymorphonuclear leucocytes, frog eggs). In all these respects the effect of tyrocidine cannot be differentiated from that of cationic detergents and it will be recalled that, on account of its free basic group and its surface activity, the substance clearly belongs to this class of compounds. The mode of action of cationic detergents is at the present time a matter of conjecture, but in any case these substances must be considered as general protoplasmic poisons (3, 34).

The effect of gramicidin on the metabolism of susceptible cells cannot be described in simple terms. Streptococci and staphylococci resuspended in neutral or alkaline solutions of potassium phosphate in the presence of glucose respond to the addition of gramicidin by a marked and prolonged stimulation of oxygen uptake and acid production. In the absence of phosphate and potassium ions, on the other hand, the same amounts of gramicidin cause a cessation or marked decrease of oxygen uptake and acid production; addition of potassium phosphate to the system immediately causes the metabolism to become greater than that of normal

cells. Of course, the transformations that go on in the utilization of glucose are complex; the situation however may be slightly simplified by the observation that these same phenomena are found in the utilization of the simpler substrate ethyl alcohol by staphylococci. Acetaldehyde, a probable intermediate in this last process, is also transformed more rapidly in the presence of gramicidin. In the case of staphylococcus, the addition of a few μg of ammonia is sufficient to completely prevent or interrupt the stimulation of metabolism caused by gramicidin. All these effects are the same, irrespective of the amount of gramicidin, provided of course a minimal amount be present (of the order of fractions of μg per cc. of bacterial suspension).

It is of great interest that spermatozoa, which are also very susceptible to gramicidin, may also exhibit marked stimulation of metabolism in the presence of this substance (33).

It is obvious therefore that gramicidin can hardly be considered as a gross protoplasmic poison but more likely behaves as a specific inhibitor blocking only one or a few metabolic reactions. On this ground may eventually be explained a number of curious observations such as the inhibition of the hemolytic effect of gramicidin by glucose, the failure of pneumococci killed by gramicidin to undergo lysis, the purely bacteriostatic and not bactericidal effect of gramicidin on group D streptococci. The difference in the mechanisms of antibacterial action exerted by the two substances is also illustrated by the fact that staphylococci which, by variation or adaptation, become resistant to gramicidin, retain unaltered their susceptibility to tyrocidine.

INHIBITORS OF GRAMICIDIN AND TYROCIDINE

Tissue components reduce the antibacterial activity of tyrocidine and it is difficult to detect the effect of this substance on Gram negative bacilli in peptone solutions, although inhibition of growth of Gram positive organisms can still readily be observed in the same media and in tissue cultures.

Serum and tissue extracts also exhibit a definite neutralizing effect on gramicidin. However, serum proteins, egg albumin, purified casein, gelatin, peptones, starch and other purified polysaccharides, fatty acids, sterols, etc., hardly if at all affect the antibacterial activity of the substance. Of all the substances so far tested (including many ether soluble compounds) only the cephalins (both phosphatidyl serine (35) and the classical colamine cephalin) have been found capable of neutralizing gramicidin. This action occurs both *in vitro* and *in vivo*; 10 μg of cephalin for instance injected intraperitoneally with gramicidin, is sufficient to prevent or reduce the protective action of the latter substance against pneumococcus peritonitis in mice. Similar amounts of cephalin also inhibit the hemolytic effect of gramicidin and its effect on the metabolism of susceptible cells. It is of special interest that one can release in solution from Gram negative bacilli a protein-free fraction rich in phospholipids which can also inhibit gramicidin. Whether this fact bears any relation to the resistance of Gram negative bacilli to gramicidin is a matter for speculation.

EFFECT OF GRAMICIDIN AND TYROCIDINE ON BACTERIAL INFECTIONS

It has been stated that tyrocidine reacts with a number of proteins, is inhibited by many tissue components and is toxic to a variety of living cells. It is not surprising therefore that in spite of its great antibacterial activity *in vitro* it loses—like other common antiseptics and especially cationic detergents—most of its activity *in vivo*. However, amounts of 0.050 mg. injected intraperitoneally into white mice can protect these animals against 1000 fatal intraperitoneal doses of virulent pneumococci; larger amounts of the substance may determine slight, but definite toxic reactions, and in fact may fail to protect against the same infective dose (9).

Gramicidin is a much less reactive substance, particularly inert toward proteins and many types of animal cells. It possesses, unfortunately, a number of other attributes which limit its effectiveness *in vivo*: (*a*) it is insoluble in aqueous media in the presence of electrolytes, (*b*) its antibacterial effect is reduced in the presence of cephalin, (*c*) it is hemolytic, and physiological concentrations of glucose are not sufficient to alter its lytic action against red cells (9, 31, 32), (*d*) it is extremely toxic to dogs and mice when injected intravenously (36). Because of these limitations gramicidin is almost completely inactive against systemic infections even caused by organisms which, like pneumococci, are extremely susceptible to it.

On the other hand, gramicidin appears to exhibit little or no toxicity when applied locally on mucous membranes and wounds, or when injected by subcutaneous, intramuscular or intrapleural routes. When administered locally at the site of the infection, it can in fact protect experimental animals

against infection with susceptible pathogenic agents. For instance, 0.001–0.002 mg. of the substance injected intraperitoneally is sufficient to protect mice against infection with 10,000 fatal doses of virulent pneumococci or streptococci (9). There are several factors which may reduce the efficacy of gramicidin in the therapy of localized infections. Within one same bacterial species, different strains may vary greatly in their susceptibility to the drug and some strains of staphylococcus, in particular, have been found to be much more resistant than others. Moreover, susceptible strains may give rise to resistant variant forms, a fact also observed most frequently with staphylococci. The neutralizing effect of cephalin on the antibacterial action of gramicidin has already been noted and it is likely that the breakdown of many types of cells results in the liberation of these inhibitory substances. Finally it will be recalled that Gram negative bacilli readily yield in solution a fraction rich in phospholipids which also inhibits gramicidin; it is to be expected therefore that in mixed infections, the presence of Gram negative components may protect the susceptible Gram positive organisms from the effect of gramicidin. It is probably to the abundance of the Gram negative flora that one may trace the complete lack of activity of gramicidin in the intestinal tract (9, 37).

On the basis of this knowledge some attempts have already been made to use gramicidin for the local treatment of localized infections. The substance has been tested in emulsion in distilled water, isotonic glucose or glycerine solutions, or mixed with oil, in a number of conditions associated with Gram positive pathogenic agents—bovine mastitis (caused by group B streptococci) (38, 39, 40, 41, 42), empyemas, sinusitis, stasis ulcers, bladder infections, conjunctivitis (30, 43) etc. It has been used also in an attempt to eliminate hemolytic streptococci and diphtheria bacilli from the rhinopharynx of carriers (44). In practically all these clinical studies gramicidin has been used in mixture with tyrocidine as tyrothricin. In some respects tyrothricin offers advantages over gramicidin; (*a*) the presence of tyrocidine in the mixture increases the stability of colloidal solutions of gramicidin, (*b*) tyrocidine has by itself some antibacterial activity *in vivo* and may even have some slight effect against Gram negative bacilli, (*c*) tyrothricin may contain active components other than gramicidin and tyrocidine which would be removed in purification, (*d*) tyrothricin is readily produced and available in large amounts. It remains possible, however, that, under certain conditions, tyrocidine may cause some toxic reactions not elicited by gramicidin. It might be advisable, therefore, to consider the use of the latter substance in a state of purity for the treatment of certain types of infections—empyemas and conjunctivitis for instance—where the drug comes in contact with very susceptible tissues.

CONCLUSION

Although the Gram staining technique was introduced as a purely empirical procedure for the detection of bacterial cells in infected tissues, it has now been recognized to divide the bacterial world into two general groups which differ profoundly with reference to many structural and physiological characteristics. The differential susceptibility of the Gram positive and Gram negative species to gramicidin is obviously the result of some fundamental difference in cellular structure or metabolism between the two groups of organisms, and illustrates the significance of comparative bacterial physiology in the problems of chemotherapy (45). It is interesting also that gramicidin is primarily bacteriostatic rather than bactericidal in its action; since it does not completely abolish, but only alters the respiration of susceptible cells, one may assume that the inhibition of growth which it causes depends, not upon interruption of cellular metabolism as a whole, but rather upon some subtle interference with certain individual reactions. In this respect gramicidin differs greatly from tyrocidine, a substance belonging to the class of cationic detergents, and which behaves as a gross protoplasmic poison.

Both gramicidin and tyrocidine are alcohol soluble substances extracted from cultures of *Bacillus brevis*, both are polypeptides in nature, and both exhibit antibacterial action *in vitro*. But whereas the former under the proper conditions retains much of its activity in the presence of animal tissues, the latter—like most common antiseptics—becomes practically inactive *in vivo*. The determination of the chemical structure of gramicidin and tyrocidine has revealed that certain types of polypeptides may be endowed with remarkable bacteriostatic and bactericidal activity and this knowledge may give valuable clues for the synthesis of new antibacterial agents. But even of greater interest is the contrast in behavior between gramicidin and tyrocidine in the presence of animal

tissues. This contrast emphasizes again that, from the point of view of chemotherapy, the main problem is no longer the discovery of more antibacterial substances, but rather the elucidation of the obscure factors which permit an antiseptic to remain active *in vivo*. It appears permissible to hope that an understanding of the chemical and physiological properties which condition the relative affinities of gramicidin and tyrocidine for bacterial cells and tissue components may suggest new approaches to the synthesis of chemotherapeutic agents.

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Manuscript Notes of John Syng Dorsey

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THROUGH the generosity of Mrs. B. G. du Pont the Library of the College of Physicians of Philadelphia possesses two manuscript notebooks of John Syng Dorsey.[1] As house pupil to his uncle, Philip Syng Physick, Dorsey recorded the first case report July 21, 1798, when he was less than fifteen years old. The last note is dated October 2, 1811. This span in effect covered the training period of young Dorsey from the apprenticeship through his early professional career in Philadelphia. These years also marked the peak of the surgical prestige of Physick. Among the very human side-lights of this devoted relationship is found a note of December 3, 1809. Confronted by a complicated strangulation of an inguinal hernia, Dorsey had called his chief in consultation. Physick concurred in the opinion of surgical urgency. The situation presented upon opening the hernial sac was formidable and Dorsey wrote, "Dr. Physick now took the knife."[2]

Two years later (August 19, 1811) the master witnessed one of Dorsey's greatest surgical triumphs in the successful ligation of the iliac artery for inguinal aneurism before a notable assemblage of physicians including Drs. Dewees, Hartshorne, Hewson, Neill, Parrish and Shaw. Present also were a number of medical students. The young surgeon graciously credited his success to a forceps devised by Physick. The painstaking progress notes bespeak the mettle of the clinician[3]:

First day postoperative:

"I examined the heat of limbs this morning accurately. Room 86°.
Toes of sound leg—90°—operated leg—88°.
Knee of sound 92°—D° knee —92°."

Third day postoperative:

"The circulation today is evidently brisker—the skin is red and when pressed becomes pale, but instantly on taking off the finger becomes red again—nearly as rapidly as sound leg—veins equally turgid in both limbs."

Sixteenth day:

"Upon examining the ligature I was astonished to find how tight I had pulled the knot—scarce any space was evidt where the vessel had been—it had not slipped in the least."

The notes in the main incorporate the daily clinical exposures of a youthful and responsive mind to the leading American surgeon of the day. As such the plane of surgery can be evaluated in the perspective of a century and a third of medical advance. One marvels at the fortitude of patient and surgeon alike confronted by the necessity of a radical mastectomy under the analgesia of laudanum alone. Hemostasis was effected by pressure and ligation; hence anatomy was more heeded in that day. The expression, "healthy pus", recurs to magnify the blessings of asepsis.

Vesical calculi were very common and Physick was one of the most famous lithotomists of the period. The following case report is cited in this relation[4]:

Lythotomy performed with the new Gorget—20th Dec. 1801.

Was present this morning at an operation for the extraction of Stone, performed by Dr. Physick at the Alms house. The Patient was a boy of about 9 or 10 years of age—from the long duration of the disease he was considerably emaciated and complained almost incessantly of pain.

After the preliminary process of sounding had been gone through the Staff was delivered to Dr. Coxe and Dr. P. commenced the operation by an incision beginning on the left side of the Raphe near the scrotum, and continued obliquely backward so as to terminate at the distance of about ¾th of an inch from the anus being about 2½ inches long—The depth of it was sufficient to lay bare the muscles of the perineum. The dissection was continued thro' these untill the Staff appeared in the urethra.

Dr. Physick's new Gorget was now introduced the width of its cutting part was ⅝th of an inch. Its beak was placed in the groove of the Staff and it was forced

[1] The earlier volume, covering the period July, 1798–May, 1800, will be designated in subsequent footnotes by its library 'call number,' Z10 65; the second volume, covering the period 1801–1811 (but including revised versions of at least two cases reported in the earlier volume), by its call number, Z10 64.

[2] Z10 64, p. 76.

[3] Z10 64, p. 109.

[4] Z10 64, p. 11.

into the bladder. The Urine flowed out immediately on its extraction. The bleeding was at first very profuse, but soon abated. A pair of forceps were now introduced through the opening; such as are used in extracting polypi, only somewhat larger. The Stone was readily grasped with them, but in attempting to pull it out, the forceps broke at the joint. The lips of the wound however prevented them from slipping off and the Stone was pulled out with them. Pat. put to bed. The Stone was about an inch in length—and ¾ of an inch broad of a flattened oval figure—very rough and of a whitish color—

Here recorded (under date of May 4, 1803)[5] may be found Physick's oft quoted case of ununited fracture of the humerus (December 18, 1802). By the use of a seton he proposed "to excite a sufficient degree of Inflamation to procure the union of the two extremities without exposing too much of the cavity." Firm union of the fragments occurred in twelve weeks.

The relaxation of a hot bath or syncope was remarked not to facilitate the successful taxis of hernias. Cataract extraction was commonly recorded. To pupil as well as master trephining and exploration subsequent to cranial injuries held no terrors; but interesting is the notation that subdural accumulations of blood should be undisturbed and dependence for their absorption placed upon active purgation.

On one occasion (May 10, 1811)[6] Dorsey was able to elicit no history in a patient unconscious after a blow to the head, except the brother's statement that the injured man had indicated a point of pain above the left ear before lapsing into coma. In consultation with Physick:

We agreed to trepan over the middle artery of the dura mater, wh was the precise spot pointed out by the patient's finger—I perforated the bone & instantly a large black clot of blood was protruded thro' the aperture—my finger was introduced & removed a great deal of clotted blood. I now found that a prodigious quantity was extravasated & I could not touch the dura mater with my finger all the left hemisphere seemed compressed against the falx & nothing but blood could be discovered.

The recovery was complete in two months.

The master inculcated a thoughtful aproach to the problems of practice as indicated by such passages as the following (December 4, 1799)[7]:

This morning Doct. Physick in order to cure a mans leg w^h had an extensive sore just below ye Calf tied up ye large venous trunk just under ye ham—The Veins below being all Varicose—his design in doing this was to take off ye Pressure of ye Column of Blood bet^n ye Vein and ye Heart—The Circulation will now be caried on by anastomosing Branches—This operation will probably facilitate ye Cure of ye Sore.

Referring to the veins below the ligature Dorsey continues,

The Veins below were swelled somewhat—ye Surface and edges of ye Sore appeared Very blue—(& not red, as they ought to be according to Priestley this is a Complete proof—Oxigene is absorbed in ye Lungs & does not act through living Vessels these being impervious)

On April 28, 1800 upon discovering the absence of arterial pulsation in a patient sustaining a laceration of the forearm with a gouge, an interesting expedient was invoked[8]:

Dr. P. not being sure of the Artery gave the Patient—whose face was cold and covered with moisture—some Brandy after a few minutes the Brandy was repeated & the Patient ordered to walk about after a few minutes —& a third dram of Brandy the Pulse became perceptible—the Artery began to pulsate—to bleed in drops—& at length in a startling stream.

Nor was the youthful house pupil lax in his notations of pertinent information. The leg had been amputated May 1, 1799[9]:

2nd. The patient is quite easy today & in good spirits. Still has the sensation of her leg & when she wakes suddenly out of her sleep she thinks she feels her old ulcer smarting.

Physick's conspicuous flare for mechanical improvisation found re-expression in Dorsey's early practice. On August 10, 1806 the latter was called to see a man suffering from urinary retention. After failure to relieve the situation with a bougie Dorsey proceeded[10],

As I was at a considerable distance from home & could not at so late an hour easily procure an elastic

[5] Z10 64, p. 46.
[6] Z10 64, p. 94.
[7] Z10 65, p. 47.
[8] Z10 65, p. 59.
[9] Z10 65, p. 15.
[10] Z10 64, p. 60.

catheter, & as I was doubtful whether I could have introduced one of the usual form, owing to the bluntness of the extremity, I lost no time, but prepared an extemporaneous catheter in the manner described by Dr. Physick in MSS Lec.

I took one of the spiral wires from my Suspenders & extended it regularly untill the length was equal to that of a common bougie, taking care to preserve a cavity still in the centre—A piece of bougie plaster (linen dipped in Melted bees wax) was applied over this, so as to cover it completely, a conical point was next formed tapering so as to become very small at the end, at about two inches from which a small hole was cut through the waxed linen, between the gyri of the wire. The instrument thus prepared was dipped in oil and very readily entered the bladder.

A rabid dog bit a boy, a negro servant, two cows, and a hog (case recorded September 15, 1802). Certain observations by Dorsey invite quotation[11]:

When this was observed the dog was tied up—and in a few days an alteration in his barking was observed which was very peculiar—he did not appear otherwise diseased for some short time, but in about a week became convulsed & died evidently of canine madness.

On the thirty-seventh day the boy developed pain in the head and became quite depressed.

The following day:

For the first time now an impediment was discovered in his pronounciation. He uttered his words suddenly and apparently with great difficulty his father recollects particularly the words carriage and River.

The thirty-ninth day:

At this time his Respiration was agitated and when he spoke his voice was much altered between each Sylable which he uttered he stopped for breath—

At necropsy Dorsey remarked,

The most striking peculiarity next observed was the aperture of the glottis. This was so contracted that a common probe to enter must have stretched it.

In analyzing this circumstance he added,

Whatever inferences may be drawn from the Circumstances of the above Case, with respect to the inflamatory nature of the disease It appears to me to prove beyond doubt that it kills by producing Spasm of the Glottis.

The occasional analyses concluding the case records are particularly illuminating. It is almost as though Physick and Dorsey were thinking aloud. In a patient proving to be a victim of empyema necessitatis (October 4, 1801) Dorsey noted[12]:

Remarks—In this Case it was difficult to decide on the nature of the contents of the tumor before it was opened—Dr. Physick had some doubts; from the strong pulsation & very fluid nature of the contents wh was evinced by its fluctuation; he was not certain but that arterial blood contained in an enlarged artery constituted the tumor, but these circumstances of pulsation and fluidity—he afterwards was convinced proceeded from the proximity to the heart & the thin Consistence of the Pus or Serum—In this Conclusion he was accurate, but Caution determined him to make a valvular orifice so that if the tumor should turn out an Aneurism, he might readily by pressure command the hemorrhage.

The Case proves that Pleuritic inflammation does not always end in adhesion but that Suppuration sometimes results from it—Quere—Did the Pleura constitute a part of the parietes of the Abscess?—Dissection was not permitted, and this point is not ascertained.

The absence of convulsions and other symptoms or signs in a patient sustaining a fracture of the skull (October 9, 1801) elicited the following[13]:

Remarks—This case appears to prove that some portions of the brain are capable of being pressed upon considerably without much influencing the intellectual operations—Daniel was not stupid, delirious nor convulsed from pressure on the brain but on the 3rd day (12th Oct^r) the inflammation produced some delirium—In other Cases of injured head a trifling pressure on the brain or indeed a fissure without perceptible depression produce Coma, Convulsion—Delirium—Vomiting, &c. It further proves the propriety of the depleting plan with a view not merely to relieve but to prevent the usual alarming Symptoms of compressed brain.

These absorbing documents afford an intimate insight into the teacher-pupil relationship between two outstanding figures in Philadelphia medicine of the early nineteenth century. The theories and practices of Philip Syng Physick are preserved to posterity largely through this medium, for the Father of American Surgery spurned the ink-pot. Many of the case records are illustrated by diagrams. Dorsey's line drawings are excellent but the water-colors suffer by comparison. Although the Notes carry one only to Dorsey's twenty-eighth year, adequate evidence of his brilliance is afforded. It is to be regretted that his effort was incomplete and interrupted before the end of his meteoric career (1818).

[11] Z10 64, p. 15.

[12] Z10 64, p. 10.

[13] Z10 64, p. 5.

Scientific Accomplishments of the United States Army Medical Corps*

Part I

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*Read, in part, before the College of Physicians of Philadelphia, the Section on Medical History, March 9, 1942, and on April 8, 1942, before the Medical History Club of the Johns Hopkins University.

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Scientific Accomplishments of the United States Army Medical Corps

By EDGAR ERSKINE HUME
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INTRODUCTION

THE late William Holland Wilmer (1863–1936) of Johns Hopkins, Brigadier-General in the Medical Reserve of the Army, in his presidential address before the Association of Military Surgeons in 1930, commented on the part of the military surgeon in science.

"Military surgeons were forerunners of medical science. Disease and obscure injuries were supposed to come from the displeasure of gods and demons, and were treated by magic. Injuries of battle, however, were inflicted by human agents. They were understandable, and necessitated some crude knowledge of anatomy and physiology; for they had to be treated by methods more rational than incantation."[1]

So military surgeons were the first contributors to medical science. That they have not ceased to make worthy contributions is well known. In the United States our officers have held their own in this field, as it is hoped that what follows will show.

Modern wars are fought, as the American people are beginning to realize, not merely by armies, but by whole embattled nations. The Armies grow to the point where they embrace nearly all of the man power of military age. So, too, the Medical Department of the United States Army is even now taking unto itself a very large proportion of the American medical profession. In the first World War there were many thousands of physicians commissioned in the service from civil life. It has been so, too, in earlier wars. Thus, in considering the scientific accomplishments of medical officers of our Army, one cannot consider the individual achievements of medical officers who are serving for the emergency only. To do so would be to consider the advance of American medicine as a whole. Therefore in this study I have confined myself to the work supervised or individually done by career medical officers. The Army may well claim the work of men who devote their lives to its service. It has no right to claim the work of others except in so far as such work was directly the result of their being in the military service.

YELLOW FEVER AND THE BUILDING OF THE PANAMA CANAL

The achievement of the Medical Department of our Army that is best known to the general public is unquestionably the proof by Walter Reed and his associates that the mosquito transmits yellow fever, and the application of this knowledge in Panama, thereby making the construction of the Canal possible. It is indeed a dramatic story.

Of Walter Reed the scholarly Brigadier-General Walter Drew McCaw (1863–1939), sometime Chief Surgeon of the American Expeditionary Forces in the first World War, said:

"It is given to but few scientific men to lay bare a secret of nature materially affecting the prosperity of nations, and the lives, fortunes, and happiness of thousands. Fewer still succeed in so quickly convincing brother scientists and men in authority of the truth of their discoveries, that their eyes behold the glorious result of their labor."

Yellow fever is an old enemy of the Army, and of the country as a whole. The Army had long tried to fight it, and in the war against no other disease have our officers done more to advance knowledge and to restrict the geographical limits of terrible "Yellow Jack". Perhaps a better way to put it would be to say that the country has the Army to thank for our not having the wide spread of yellow fever that was such a real terror a generation ago.

As early as 1793, that great Philadelphian and Signer of the Declaration of Independence, Surgeon General Benjamin Rush (1745–1813) played an important part in fighting the epidemic of yellow fever in his native city. His account of his work is unapproached for its realism. Rush thought the cause of the disease was "general constitution of the air, coöperating with miasmata", a statement not so far wrong if we consider that the evil agents in the air were not invisible but both visible and audible.

[1] *Military Surgeon*, 1930, **67**, 727–732.

In 1820 Surgeon's Mate Ayers P. Merrill, Eighth Infantry, outlined a new treatment of this disease, which, while not perhaps in keeping with modern clinical methods, at least had the merit of giving great relief to sufferers in comparison with the extensive venesection and massive doses of purgatives that had been used up to that time.

Surgeon General Sternberg made important contributions to the knowledge of yellow fever. He had extensive experience with epidemics of the disease, particularly at Fort Columbus, (now Governor's Island), New York, in 1871 and at New Orleans and Fort Barancas, Florida, in the following year and again in 1873 and 1875. His first publication of scientific value related to the clinical picture.[2]

Sternberg's search for the specific organism of yellow fever began in 1879 when he was a member of the Havana Yellow Fever Commission. He continued the work for a decade or more, visiting both Cuba and Brazil in his work. His report made at the end of these extended researches, showed that all the studies made theretofore had failed to demonstrate the specific cause of yellow fever. He disapproved of the generally accepted claims of Domingos Freire of Brazil to have discovered the "germ" of the disease. Freire's "*Cyptococcus xanthogenicus*", and his efforts to produce immunity by inoculations were without scientific foundation. Sternberg likewise showed that the bacillus of Gibier, *Bacillus leporis lethalis*, Finlay's *Micrococcus tetragenus* and his own *Bacillus acidicornis*, *Bacillus cuniculicida havaniensis*, and other suggested agents, bore no etiological relation to the disease. In his textbook he said: "The researches made up to the present time [1892] have failed to demonstrate the constant presence of any microörganism in the blood and tissues of those attacked . . . The possibility, of course, remains that the specific infectious agent in yellow fever may belong to an entirely different class of microörganisms from the bacteria, or that it may be ultra-microscopic or not capable of demonstration in the tissues by the staining methods usually employed by bacteriologists".[3] We can add, half a century later, but little to this statement. Sternberg must be accorded much credit for his work. As his old friend and associate Dr. William Henry Welch said: "It is a common thing to forget the steps which led up to important discovery; all that Sternberg had done in the study of yellow fever was necessary work, and it had to be done in just the way that he did it. The ground had first to be cleared; if it were not so the discovery had not been possible, and later discoverers themselves would have had to hunt out the large number of microörganisms which Dr. Sternberg had described and laid aside."

When the Scoto-Cuban, Dr. Carlos Juan Finlay (1833–1915), stated his theory in 1881 of the mosquito transmission of yellow fever, a great step forward was made, though one must not forget that Josiah Clark Nott (1804–1873) had assumed this in 1848. General Sternberg realized the necessity of further work in the pathology of the disease and sent Major Walter Reed (1851–1902) to Prof. Welch's laboratory at Johns Hopkins for that purpose. Sternberg told Reed that in his opinion the *Bacillus icteroides* of Sanarelli was not the cause of yellow fever, as was commonly supposed. Reed's work in the pathology of this disease was outstanding but is overshadowed by his greater work.

The Spanish-American War gave, in 1898, a great impetus to the study by Americans of yellow fever. There was the not unusual epidemic of yellow fever in Havana and there was every reason to consider that disease the most potent enemy to be faced by our soldiers.

It seems only fair that it should fall to the Americans to rid Havana of this disease for it seems probable that it was first introduced into the island by American Colonial troops when the city was taken by the British in 1762.

Walter Reed's prestige as the head of the board that studied typhoid fever in the camps in the United States made him Sternberg's natural choice to head the Yellow Fever Board, the most famous scientific group that our Medical Department has ever had. The other members of the Board were: Majors James Carroll (1854–1907), who submitted to inoculation with the disease, Jesse William Lazear (1866–1900), who died from the effects of a permitted mosquito bite, and Acting Assistant Surgeon Aristides Agramonte (1868–1931), a native of Cuba and later Professor of Pathology at the University of Havana.

Reed and his associates proceeded in an orderly and logical way to test the theory of Carlos Finlay that the mosquito transmits yellow fever. They

[2] *New Orleans Med. & Surg. Journal*, 1875–6, n.s. **3**, 1–23.

[3] Sternberg, G. M. Manual of Bacteriology. N. Y., Wood, 1892. Pp. 529, 531.

first showed that the insect, then called *Culex fasciatus*, later known as *Stegomyia fasciata* and now *Ædes egypti*, was present at the time and place of the epidemic. Next that epidemics usually started in low wet regions and that the higher and dryer parts of an affected area were relatively free from the disease, though persons who had fled from the "miasma" of the low areas might come down with yellow fever after reaching the high places. The disease seemed to be spread in the direction of the prevailing wind, thus strongly suggesting insect transmission to Reed, as it had to Finlay. Cool weather, with a reduction in mosquitoes, stopped epidemics of yellow fever. Indeed this commonly known phenomenon was considered by many persons to be the only way an epidemic could be halted. Witness the following lines published in Harper's Weekly for 19 October 1878:

This fragrant beauty seems the mask of Death
The whispering south wind is his poisoned breath;
We weary for these warm bright days to end;
  The summer lingers at what fearful cost:
  Pitying God! in mercy to us send
  The white gift of Thy frost!

In 1900 Surgeon Henry Rose Carter (1852–1925), of the United States Public Health Service, had shown that a period of twelve to fifteen days must elapse before a case of yellow fever becomes dangerous to others. This, the observations above noted, and Finlay's theory were the groundwork upon which Reed and his associates sought to build.

Reed obtained volunteers for the necessary human experimentation, for as he explained to the military authorities, animals cannot be used for this purpose. A group of brave enlisted men of the Medical Department of the Army volunteered for this, refusing pay. There was also a group of Spanish laborers who were paid for submitting to Reed's experiments. Men that Reed allowed infected mosquitoes to bite came down with disease. It was shown that only the mosquito could be guilty, by having men sleep on the soiled clothing and bedding of yellow fever patients in a screened room without becoming infected. Some of these same individuals were later infected by the bites of *Ædes*. There is hardly space or necessity to give the very details of Reed's work for it is as well known to the public as any other piece of scientific investigation ever made.

Reed returned to the United States and was justly accorded high honors by learned societies and universities. Years after his death Congress (1929) created a special gold medal to be presented to each member of Reed's commission and each of the volunteers for the experiments. But Reed had been dead more than a quarter of a century, so his medal was presented to his widow. Walter Reed Hospital in Washington, the Army's largest hospital, bears his name.

There is a sad epilogue to Reed's story. He had desired above all possible Army assignments to be made the head of the Army Medical Library, then usually known as Library of the Surgeon General's Office. Indeed Billings, with his unerring judgment of men, had already selected Reed for this duty, but the younger officer was not then available for it. However, in 1902 Reed was made Librarian and wrote that he had "attained the highest ambition of my life." He held office but a single week, for his career was cut short by his untimely death from appendicitis, which operation could not prevent. So there passed one of American's great men of science, at the end of "fifty-one years of industrious blameless life" as General McCaw put it.

The task of putting Reed's discoveries to practical application fell to Major William Crawford Gorgas (1854–1920), later Surgeon General of the Army and the best known man who has held that office. Gorgas was appointed Chief Sanitary Officer of Havana on 10 February 1900. Under the orders of another great military surgeon, Major General Leonard Wood (1862–1927), then in command, he instituted measures now practiced everywhere in combatting mosquito-borne diseases. He screened yellow fever patients, destroyed mosquitoes and their breeding places, etc., and in three months Havana was freed from the pest for the first time in a century and a half.

The success of Gorgas in Havana led naturally to his being put in charge of similar work in the newly acquired Canal Zone in 1904. Here what had been a notorious plague spot of disease, the "White Man's Grave," as it was called, was converted into one of the healthiest of communities. Gorgas continued the methods which had proved so successful in Havana. In the face of much stupid opposition at first, Gorgas never hesitated in attaining his objective, that of making the isthmus free from disease before the operations on the canal were commenced. While the elimination of other

disease was no less important than that of yellow fever, this malady comes first in the minds of the general public. Under the French occupation it was a byword that every tie laid on the Panama Railway cost a life. From 1881 to 1889 the French lost more than 22,000 laborers by death, an annual rate of 240 per thousand. One station on the old Panama Railway was called *Matachin*, from the Spanish word *matar* (kill, and *Chino* (Chinaman), because 1,000 Chinese coolies at this point died off in six months, as did also 1,000 Negroes from the West Coast of Africa.

When the United States took charge of Panama the death rate was 40 per 1,000. A yellowfever epidemic raged from July, 1904, to December, 1905. In less than a year Gorgas had eradicated it entirely and there has not been a single case of the disease there since May, 1906.

In one of his reports Gorgas said:

"When the Canal shall have been finished it can be shown that sanitation cost about $365,000 per year. For a population of 150,000, this means an expenditure of about one cent per caput per day, and this sum is well within the means of any tropical country."

Elsewhere he wrote:

"I do not believe that posterity will consider the commercial and physical success of the Canal the greatest good it has conferred upon mankind. I hope that as time passes our descendants will see that the greatest good the Canal has brought was the opportunity it gave for demonstration that the white man could live and work in the tropics, and maintain his health at as high a point as he can, doing the same work, in the temperate zone. That this has been demonstrated none can gainsay."

During the remainder of his life Gorgas was frequently called to distant parts of the tropical world to give advice and assistance. After his retirement from active duty, after having served as Surgeon General through the World War, he was on his way to South Africa for the purpose of taking up yellow fever work for the International Health Board, when, delayed in Europe by the award of many honors, he died suddenly in London, having been knighted on his deathbed by King George V. As Colonel Ashburn said, "He was a verray parfit gentil knyght." Gorgas General Hospital in the Canal Zone bears his name.

In 1914, in admitting Gorgas to the degree of Doctor of Civil Law, Chancellor Warren, of Oxford, thus saluted him:

> Hail Router of the Plague of Flies!
> Hail Isthmian Conquerer true!
> Gorgas, to that wise Goddess dear,
> The Gorgon, Death, who slew!

In 1906 during the period of our second intervention in Cuba, Major (now Brigadier General, retired) Jefferson Randolph Kean, a medical officer who had already been commended for his work in helping the Reed Yellow Fever Board, and curiously enough, the first yellow-fever patient that his friend Reed had ever seen, was placed in charge of sanitary affairs in the island by President Taft. This position he held throughout the entire period of occupation, and during this time he extinguished yellow fever, which had reinvaded the island during the first Cuban republic, and owing to the great increase in the non-immune population had spread all over Cuba. In 1900, when yellow fever had been extinguished in Havana, it disappeared from the entire island.

The preventive measures used by Reed and Gorgas have been, and are being, put into effect in many tropical lands. In his report on "Twenty-Five Years of American Medical Activity on the Isthmus of Panama," a work received with enthusiasm in Britain, France and elsewhere, Colonel Weston Percival Chamberlain, Health Officer of the Canal, said:

"By far the larger part of the morbidity and mortality formerly attributed to tropical climates was due, not to climate per se, but to isolation, nostalgia, venereal disease, alcoholic excess, poor municipal conditions, and, most important of all, to infection with specific parasites whose invasion is now entirely preventable. . . . "

Commenting on which, Sir William Horrocks remarks, "This may justly be regarded as a triumph of preventive medicine."

The discovery of "Jungle Yellow Fever" in South America in recent years, transmitted by other vectors than *Ædes*, has greatly added to the military problem. The Army's latest measure is directed to protecting soldiers who may have to serve in areas in which jungle yellow fever is found. On 6 February 1941 the Secretary of War, upon the recommendation of the Surgeon General, required the immunization against yellow fever of all men ordered to tropical areas. On 12 February 1942, the Secretary extended this requirement and

directed that all personnel of the United States Army be given the prophylaxis. Thus the American Army is the first in the world to receive general immunization against yellow fever. The vaccine used is the attenuated virus developed through prolonged cultivation of tissue cultures. It is distributed in frozen ampules. At present the vaccine is being prepared in the laboratories of the International Health Division of the Rockefeller Foundation, New York.

TYPHOID FEVER AND ITS PREVENTION

Typhoid fever has undoubtedly been one of the great causes of disability of soldiers in wars of the past. Of course the records are not clear prior to 1837 when Gerhard differentiated typhoid from typhus fever, but the circumstances surrounding epidemics often show us which disease the author discusses. Certainly the army had its full share of typhoid fever in the days in which it was so widely spread through the civil population. Surgeon General Lovell, in writing of the diseases which prevailed during the War of 1812, distinguished *typhus gravior* (apparently typhoid) and *typhus mitior* (apparently typhus).

During our Revolution there was more than one outbreak of jail fever, and one is led from the accounts of Surgeon James Tilton (1745–1822), later Surgeon General, to think that some of them were in reality typhoid fever, instead of typhus fever, which the term jail fever usually connotes. In the War of 1812 and the Mexican War there were many cases of the disease, and there are likewise recorded numerous outbreaks in garrison during the days of peace that preceded the War Between the States. But we cannot be sure of our statistics on account of lack of clarity in the diagnoses.

Even for the War Between the States it is difficult to derive satisfactory rates. The term "Bilious Remittent Fever," sometimes a synonym for dengue, was also used for what was almost certainly typhoid. The diagnosis "Typho-Malaria" was widely used, as well, being employed to take the sting out of an outright diagnosis of typhoid fever—a practice which was still common in rural districts when I was a boy. In 1862, however, the diagnosis typhoid fever was made official and thereafter we have data worth considering. From that time until 30 June 1866 there were 57,400 cases with 5,360 deaths reported under that name. Surgeon Joseph Janvier Woodward (1833–1884) always opposed the term "typho-malaria," and so stated in his address before the International Medical Congress of Philadelphia, 1876 (p. 333).

With the mobilization of troops for our brief war with Spain in 1898 this same fever spread rapidly through the camps, though reported under a variety of terms. More than 20,000 cases of typhoid fever occurred in the military camps in the United States alone. A board of three medical officers was appointed by Surgeon General Sternberg to study the cause of the epidemics. Its members were Major Walter Reed (who while doing graduate work at Johns Hopkins under Professor William Henry Welch (1850–1934) had already made an important contribution to the pathology of the liver in typhoid fever), Major Victor Clarence Vaughan (1851-1929), sometime Professor at the University of Michigan, and Major Edward Oram Shakespeare (1846-1900). This board's work is more famous than that of any other in our Army, save only the Yellow Fever Board. Major Walter Reed was the chairman of both.

The Reed-Vaughan-Shakespeare Board, as it is often called, showed by their careful investigations that more than ninety per cent of the volunteer regiments developed the disease within eight weeks after going into camp; that typhoid fever is disseminated by the transfer of the alvine discharges from infected individuals to the alimentary canals of the well; that camp pollution was a more prominent cause in this instance than contaminated water supplies; that the disease was largely spread by flies on the clothing and hands of human carriers; etc. In the epidemics of the Spanish-American War the deaths from typhoid fever were 86.24 per cent of the total deaths, the morbidity from the disease was 151.05 per 1000 mean strength, the mortality was 15.82 per 1000 of mean strength in a force of 107,973 men. A terrible story indeed!

The South African War was fought between the British and Boers (1899–1902) just after our Spanish War. Our British cousins repeated all our mistakes. Shortly before that time Sir Almroth Wright, professor at the Royal Army Medical College, London, had begun to practice immunization against typhoid fever by the use of killed cultures of the causative microörganism. This protective inoculation was wholly voluntary. But the British Army did not put it into general use. Of a total strength of 380,653 men, there were 57,684 cases and 8,225 deaths, or a morbidity of 151.15 and a mortality rate of 21 per 1000 mean

strength. So enteric fever, as it is called in Britain, was losing nothing of its killing and disabling power.

It will be remembered that there had been discouraging reports of a "negative phase" following the inoculation against typhoid fever and unfortunate accounts of higher mortality amongst vaccinated troops in infected areas than in unvaccinated troops in less infected areas. Therefore in 1903 the British Army prohibited Wright's typhoid prophylaxis. Finally the Royal College of Physicians of London vindicated Wright's procedure and the typhoid prophylaxis was again put into use in the British Army. Though it was not required, 82.3 per cent. of British soldiers in India received the treatment in 1910.

It was the United States Army which first adopted compulsory prophylaxis against typhoid fever. In his Annual Report for 1908, Surgeon General Robert Maitland O'Reilly (1845–1912) reported a low admission rate for the year and added that he was investigating the merits of the prophylaxis then being tried in certain foreign armies. His investigation took the form of sending the brilliant Major Frederick Fuller Russell, Medical Corps, to Europe to study the matter. Russell's report was described by the Surgeon General as "a very valuable treatise on the epidemiology of this disease up to date." Major Russell was a professor at the Army Medical School and later rose to the grade of Brigadier-General, becoming head of the International Health Board and is now a member of the Harvard faculty.

The Surgeon General created a board of officers to make recommendations on the matter of the proposed prophylaxis for the Army. The members were, besides Russell, six officers of the Medical Reserve, all eminent in the medical profession of America. They were, Victor Clarence Vaughan (who, as we have seen, was a member of the board which studied typhoid fever in 1898), William Thomas Councilman (1854–1933), Alexander Lambert (1861–1942), William Sydney Thayer (1864–1932), John Herr Musser (1856–1912), together with Simon Flexner who is living. The board reported their opinion that "the practice of anti-typhoid vaccination is both useful and harmless and offers a practicable means of diminishing the amount of typhoid fever in the Army both in times of peace and war."

In the following year (1909), Major Russell began the gigantic experiment of vaccinating the U. S. Army against typhoid fever. From a morbidity of 173 cases in that year he was able to bring the statistics down to nine cases in 1912, with but one fatal case reported. The officers and men who volunteered for the experiments merit the lasting thanks of their countrymen. In 1911 the prophylaxis against typhoid fever was made compulsory. With the mobilization of troops on the Mexican Border in the following year Russell had ample opportunity to test results in the field. During this mobilization he vaccinated some 20,000 men against typhoid, and the only case occurring in camp was that of a non-vaccinated teamster.

Then came the first World War. At first the only one of the armies adequately vaccinated was the British. In 1914 alone there were more than 45,000 cases in the French Army. In 1915 the rate per 1000 was four in the British, 18 in the Italian, and ten in the Belgian armies. In that year there were more than 125,000 Austrian and 64,000 German cases (strength not known). And so it went. But the practice of protecting their men against this disease became more and more common until all the armies on both sides required it and in the last year of the conflict no army had a rate as high as one per thousand. The following table shows this:

Country	Rates per 1,000 per annum	
	Morbidity	Mortality
France	14.86	1.81
Italy	6.24	
Belgium	3.59	0.57
Great Britain	1.02	0.04
United States	0.35	0.05

It has not been possible to obtain the accurate strength returns for the German or Austro-Hungarian armies, but the absolute number of cases of typhoid fever was 112,364 and 171,601, respectively, both figures being higher than the number of cases in any of the allied armies.

Perhaps the most striking way of setting forth the value of typhoid prophylaxis is to state that had the rates of the Spanish-American War been in effect at the period of the World War, the United States would have had not 1,572 cases of typhoid fever among its soldiers, but more than half a million.

During the period between the first and second World Wars the Medical Department of the Army had another opportunity to make a contribution to the control of typhoid fever. The Civilian Conservation Corps had an average of 300,000 young men of the age groups most susceptible to typhoid. The cumulative case rate per 1,000 strength per annum (1933 until the declaration of the national emergency) was less than 0.25 cases per 1,000 per year. The 1936 rate was 0.08 per 1,000, a remarkably low figure which illustrates the result of controlled Army prophylaxis when administered to a body of civilian young men. For 1936 and 1937 the typhoid and paratyphoid case rate in the United States was 12.4 cases per 100,000 population. The typhoid death rate per 100,000 population in the United States for 1935, 1936 and 1937 was 2.4.

One sometimes hears it said that the lowering of the incidence of typhoid fever in the army is but an evidence of improved community sanitation throughout the country. It is undoubtedly true that the factors which have reduced the typhoid rate in the country as a whole have also served to reduce it in the Army as well. But the reduction in the Army is far greater in extent. In five years (beginning with compulsory typhoid prophylaxis in 1911) the Army accomplished more than the United States as a whole accomplished in thirty years. The Army mortality rate for this disease was reduced to 3.24 cases per 100,000 by 1915, while that ratio was not achieved in the civilian population until 1935.

A corollary to all this is the story of the manufacture by the Army Medical School of typhoid fever vaccine. Not only does the Army Medical School make all that the Army uses, but likewise all that the United States Navy and United States Public Health Service use, as well as that made for certain other Government departments, and even some for sister nations. There are excellent facilities at the Army Medical School for this work, the magnitude of which is surprising to those not familiar with the Army Medical Corps. During the seven year period just before the National Emergency which culminated in the attack on the United States by Japan in December, 1941, the Army Medical School manufactured more than enough typhoid vaccine for a million prophylaxes per year. This means more than 2,500 liters of the vaccine each year, an enormous quantity. In 1937 half a million doses of the vaccine were used in protecting civilians during the Ohio River floods. The amount of vaccine now being made at the Army Medical School is not at present announced, but it may be said that it is adequate to the needs of all our armed forces. In 1916 the strains of Paratyphoid Bacillus A and B were added to the vaccine.

No reference to our Army's work on typhoid fever would be complete without inclusion of the name of Colonel Henry James Nichols (1877–1927), who contributed much to our knowledge of the mechanism of carriers. His monograph *Carriers in Infectious Diseases* (1922) is authoritative.

Since flies play a deadly part in the dissemination of typhoid fever, as well as other intestinal diseases, measures against them may be considered as part of the general campaign against typhoid fever. An efficient window screen fly trap, devised by Major Arthur Parker Hitchens at Fort Sheridan, near Chicago, is a step in this direction. The Indian Medical Service has made this fly trap an official implement for regular use in India. The device is described in *The Military Surgeon*, 1933, **73**, 20–28.

The most recent publication by Army medical officers on typhoid prevention is from the Research Laboratories of the Army Medical School: *Immunization to Typhoid Fever: Results Obtained in the Prevention of Typhoid Fever in the United States Army, United States Navy, and Civilian Conservation Corps, by the Use of Vaccines; Influence of Antigenic Structure and other Biogenic Characters of* E. Typhosa *on the Production of Protective Antibodies in the Blood of Immunized Individuals; Increases in Protective Antibodies in the Blood Following the Use of a Single Small Dose of Vaccine for Reimmunization Purposes as Compared with the Use of Three Doses* (1941). The title-page bears the names of nineteen Army medical officers, the senior being Colonel Joseph Franklin Siler. This is one of the Monographic Series of the *American Journal of Hygiene* (Johns Hopkins Press) and is valuable, deserving a better title-page than this clumsy one whereon there are actually 361 words!

VACCINATION BROUGHT TO AMERICA BY AN ARMY MEDICAL OFFICER

It was a Surgeon of the Regular Army who introduced vaccination into the United States. He was Hospital Surgeon Benjamin Waterhouse (1754–1846), a native of Rhode Island and Pro-

fessor of the Theory and Practice of Physic at the Harvard Medical School.

Waterhouse held the rank of Hospital Surgeon, Regular Army, in the War of 1812. In the *American Clipper*, April 1942, there is offered for sale a letter of 18 March 1815 from Waterhouse to ex-President John Adams, who transmitted it to President Madison. Waterhouse states that the Battle of New Orleans has been won, peace established, and only a small part of the Army to be kept. He has heard that only two Surgeons are to be retained on active duty and fears he may lose his commission. He must retain it, and gives his reasons, which are a review of his life's work. He emphasizes his service as the father of vaccination, his public lectures, his creation of the natural history department at Cambridge. His profitless professorships, his poverty stricken practice of medicine, etc. are mentioned. He quotes Thomas Payne and refers to General Washington and others whom he has known. All are dead save Adams whose aid with President Madison he begs. Surgeon Waterhouse was retained in service and in 1818 promoted Post Surgeon. He was honorably discharged in 1821, a quarter-century before his death.

Edward Jenner's epoch-making work, *An Inquiry into the Causes and Effects of the Variolæ Vaccinæ*, was published in London in 1798. A copy was sent by Dr. John Coakley Lettsom (1744–1815), of London, to his friend Waterhouse, who was immediately inspired by Jenner's work. Waterhouse wrote:

"I was struck with the unspeakable advantages that might accrue to this country and indeed to the human race at large from the diffusion of a mild distemper that would ever after secure the constitution from that terrible scourge the smallpox." He published an account of all this in the *Columbian Sentinel*, 12 March, 1799, under the title *Something Curious in the Medical Line*, a headline which shows Waterhouse to have had the newspaperman's instinct.

In July 1800 Waterhouse secured some of the Jennerian vaccine from England and, with the courage of his convictions, vaccinated his own children and several servants, seven persons in all. As soon as the vaccination "took" these seven individuals were sent to a licensed smallpox hospital in Boston where they were inoculated with smallpox virus as a test of the protection supposedly afforded by cowpox. Inoculation was in common use at this time, having been introduced in Europe in 1721 through the interest of Lady Mary Wortley Montagu (1689–1762), and into America in the same year by the Rev. Cotton Mather (1662–1727) and Dr. Zabdiel Boylston (1679–1766). As early as 1776 inoculation of soldiers in the Continental Army was general though not required by Regulations. Smallpox during the Quebec Campaign had made men realize the danger.

Waterhouse's human experiments were successful and none of the persons he had vaccinated were affected by the inoculation with actual smallpox virus. Waterhouse had the only supply of the cowpox vaccine in America and was loath to distribute it too freely until there was a general appreciation of its benefits. He allowed Dr. Lyman Spalding to have some of the "matter" provided he would return "one quarter of the profit arising from the inoculation." This seems to have been Waterhouse's usual fee, and Spalding's biographer has made reference to a "vaccination trust." Certainly it was fee-splitting, though that practice was hardly frowned upon at that day.

Waterhouse never lost sight of the crusade he had in mind, to establish vaccination in the United States. In 1800 he published a forty-page book: *A Prospect of Exterminating the Small-pox; Being the History of the Variolæ Vaccinæ or Kine-pox, Commonly Called the Cow-pox As it Has Appeared in England: With an Account of a Series of Inoculations Performed for the Kine-pox in Massachusetts.* A second part of this work appeared in 1802, and contained copies of letters Waterhouse had received from Jenner, Thomas Jefferson, and other great men. Waterhouse noted:

"Dr. Jenner has been to me what the sun is to the moon—Dr. Jenner has just sent me a present I highly value, a silver box inlaid with gold of exquisite taste and workmanship, bearing the inscription: 'Edward Jenner to Benjamin Waterhouse.' But Mr. Ring (a disciple of Jenner) annexed the superscription in rather an hyperbolical style: 'From the Jenner of the Old World to the Jenner of the New World.'" Dr. Oliver Wendell Holmes was vaccinated by Waterhouse.

Smallpox vaccination, thus introduced, has become the universal practice in the United States. The measure was not made compulsory in the Army at the time Surgeon Waterhouse advocated it, probably because this was one of those unfortunate periods of legislative shortsightedness when

Congress thought no army was needed. We have had a number of penny-wise-pound-foolish eras in our national development. The threatened war with France having come to naught at the turn of the century, Congress in 1800 passed a bill discharging all the troops that had been raised, including the Physician General and all medical officers save six surgeons and six surgeon's mates. With no United States Army in existence there were obviously no soldiers to vaccinate.

WHOLESALE ATTACK ON SMALLPOX

When the United States Army occupied the Philippines, Puerto Rico, and Cuba during the Spanish-American War and the period immediately following, smallpox was found to be so prevalent that it was said that people thought no more of it than of an attack of prickly heat. Medical officers were not slow in undertaking wholesale vaccination.

In Puerto Rico the disease was endemic, but by December, 1898, the incidence of smallpox assumed such proportions that an epidemic was threatened. Reports of post surgeons for November and December showed that 3000 cases had been noted within this brief period. The Chief Surgeon of the Division, Major (later Colonel) John Van Renssalaer Hoff (1848–1920) was given what he asked, the authority to vaccinate the entire population of the island. He even included infants under six months of age. As it had been found that virus from the United States lost its potency on reaching the island, the Medical Department of the Army established a vaccine farm at Coamo Springs. It was successively under the command of Major Azel Ames (1845–1908) and Captain (now Colonel, retired) Frederick Pratt Reynolds. Cattle were abundant, costing but one dollar a head. With the coöperation of Puerto Rican physicians and the local *alcaldes*, the work was soon done. Despite the rainy season, which converted mountain streams into torrents, the work was successfully completed. In less than three months 800,000 persons were vaccinated. By October, 1899, there was not a single case of smallpox known to either military or civil authorities. The total cost of the work had been $32,000 or about four cents for each person vaccinated.

In Manila when American troops entered, they found a statue in honor of the man who had introduced vaccination into the Philippines in Jenner's day. But more practical application of the Jennerian discovery was wanting. As in Puerto Rico, the disease was endemic and a large proportion of inhabitants bore the marks of the infection. Colonel Louis Mervin Maus (1851–1939) as Commissioner of Health in Manila, undertook the enormous campaign of vaccinating the population of the islands. The task was more difficult than in Puerto Rico because of the greater number of people, the scattered settlements, and most serious of all, the insurrection. Despite all these difficulties the objective was gained and the population vaccinated. Since that day small pox has never been a serious problem in the Philippines.

When we created the Civilian Conservation Corps in 1933, it was found that of the first 30,000 young men enrolled, over 30% were unprotected from smallpox. Though vaccination was required by law in most States, that law was not being enforced. This laxity resulted in 1937 in 11,673 cases of smallpox in 48 States, but there were no cases in the United States Army.

THE PHYSIOLOGY OF DIGESTION

"Every physician," said Dr. Victor Clarence Vaughan (1851–1929), "who prescribes for digestive disorders and every patient who is benefitted by such a prescription, owes gratitude to the studies of William Beaumont, who in 1825, on the Island of Mackinac, began his studies of digestion, which he pursued with labor and skill for the benefit of mankind."

Beaumont (1785–1853) is one of the best known of the United States Army's medical officers. The Beaumont Medical Club of Yale preserves his name, which is also borne by the Army's large general hospital at El Paso, Texas. In St. Louis one may see a collection of Beaumontiana, while Jesse S. Myer's *Life and Letters of Dr. William Beaumont* (1912; New Printing, 1939) recounts the story of his work. Recently Dean Cornwell has given us a painting of Beaumont by the bedside of his famous patient.

Born in Lebanon, Connecticut, William Beaumont learned medicine under the old apprentice system, acquiring a license to practice in 1812 in time to receive a commission as Surgeon's Mate in the Sixteenth Infantry, United States Army. He served throughout the war and was commended for his efficient services. This last resulted in his being retained in the Army when it was so drastically reduced in size. However, Beaumont was

a sort of stormy petrel and was always engaged in some controversy or other. In 1815 he resigned from the service, possibly in part due to his having engaged in print with an adversary, neither man hesitating to speak his mind in public. Beaumont then conducted a store, containing a general assortment of drugs, medicines, groceries, dyewoods, etc.

Like many another officer who has left the service for civil employment, Beaumont sought to return to the Army. He was commissioned Post Surgeon on 4 December 1819 and in the following year ordered to Fort Mackinac, a frontier post where Indians and *voyageurs* came in great numbers. Gunshot wounds were no rarity, but one came under Beaumont's observation which gave him a chance to make scientific observations and to win a place in America's pantheon of medical worthies. A half-breed, Alexis St. Martin, was accidentally shot in 1822, the bullet doing extensive damage, fracturing a rib, rupturing a lobe of a lung, and resulting in a piece of rib entering the stomach. The consequent fistula never completely healed and Beaumont had his chance to observe gastric digestion in process.

Beaumont has left us a record of his famous patient that could hardly be excelled by our best surgeons or physiologists, for all that he possessed no medical degree. Beaumont reported the case to Surgeon General Lovell, who had the report published and encouraged Beaumont to continue his studies. Beaumont received permission to take his now famous patient to Fort Niagara, New York, where there were better facilities for treatment. St. Martin escaped and Beaumont's work came to a stop. But, paying from his own pocket the costs of tracing the clinical fugitive, Beaumont got St. Martin to return and finally in 1832 signed a covenant with him, whereby the patient was to remain with the surgeon for one year and in return receive his food, quarters and clothing. Beaumont took leave of absence and prepared to take St. Martin abroad to show him in great medical centers. Though this journey had to be given up, the medical profession of the country became much interested in Beaumont and his patient. Some of our foremost clinicians journeyed to see him, including, for instance, Robley Dunglison, who went to Washington from Charlottesville for that purpose.

Surgeon General Joseph Lovell (1788–1836) had always been very considerate of Beaumont in giving him leave of absence to carry on his work. Lovell's successor, the colorful Surgeon General Thomas Lawson (1789–1861), disapproved Beaumont's application for further leave and Beaumont resigned from the Army for a second time, 31 December 1839.

Beaumont continued to work with, and one might say on, St. Martin, until the end of the officer's life. The story of the patient's frequent "escapes" and the student's inevitable pursuit is one of the fascinating bits of our medical history.

Beaumont's accounts of his work appeared in several installments. In 1825 his first report to Surgeon General Lovell was published in the *Medical Recorder*. In 1833 he published his *Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*, Plattsburgh, F. P. Allen. "To the medical bibliographer," said Osler, "there are few more treasured Americana than the brown-backed, poorly printed octavo volume of 280 pages. . . . The pioneer physiologist of the United States and the first to make a contribution of enduring value, his work remains a model of patient, persevering research." Beaumont himself said: "Truth, like beauty, when unadorned is adorned most, and in prosecuting these experiments and inquiries, I believe I have been guided by its light."

When Beaumont's temperamental patient died in 1880 at an advanced age and the father of twenty children, Osler tried to obtain his stomach for the Army Medical Museum. But there came a telegram of warning: "Don't come for autopsy; will be killed," and St. Martin's neighbors guarded his grave by night.

PURIFICATION OF DRINKING WATER

It took folk a long time to realize that clear sparkling water gushing from the earth may be dangerous. Today water with noticeable taste would be refused by most thirsty people. But an older generation felt differently. "Hoots," said the old Scots woman in contempt on being given water from the new reservoir, "Hoots, it has naether taste nor smell!" I have seen country people in my youth decide by taste alone whether water were pure or not. But people then believed in "water witches" and still employed one when a well was to be dug.

It was a Scottish military surgeon, Dr. Francis Home (1717–1813), later Professor in the University of Edinburgh who, while serving with British

troops in Flanders during the War of the Austrian Succession (1740–1748), promulgated a series of sanitary orders which were both wise and ahead of their times. One was that "the dragoons shall drink no water without it be first boiled."[4] Perhaps this was the first time this precaution was put into effect.

With the passage of time people came to fear water as the cause of disease. Prior to the advent of bacteriology the fear was usually that the water contained some poisonous chemical or had been polluted by dead bodies. Later when the general public came to know about "germs," as they were called, water was blamed for many outbreaks of disease in which it played a secondary part if any. The findings of the commission of which Major Walter Reed was the head, during the Spanish-American War showed that the outbreaks of typhoid fever were due largely to contact—"food, fingers and flies," as Osler put it.

But the danger from contaminated drinking water had been made known to the public, and military commanders sought medical advice as to procurement of safe water.

In the Army the responsibility for the water supply, in peace as well as in war, is divided between the Corps of Engineers and the Medical Department. In general, the Engineers are responsible for the *quantity* of the drinking water, and the Medical Department for its *quality*. Here is one of the many examples of the necessity of coöperation and understanding between two branches of our military service. One of the more modern phases of the problem is that pertaining to the rendering safe of water that has been contaminated by warfare chemicals.

Sterilization of water by heat, dating from Home's time, was the first method in general use in the Army. One of the first forms of apparatus was the Forbes Sterilizer, remembered by those who served in the Philippines in the "Days of the Empire." This sterilizer was unsatisfactory, for it violated all military principles. It lacked mobility, it was complicated, and it was expensive. Moreover, by merely tilting it, it was possible for water to pass through without sterilization, a makeshift that appealed to those who cared only for the letter of the regulations.

Filtration in the field was also tried. The Darnall Filter, devised by Major (later Brigadier-General) Carl Rogers Darnall (1867–1941) of the Medical Department, was an ingenious adaptation of the principle of mechanical filtration to field needs. It was widely used. The complete filter weighed about 52 pounds and was capable of delivering 200 gallons of water in four hours. The Japanese Army once used a mechanical filter in the field, the Eshitzi Filter, in which the water passes through charcoal and sponge discs after preliminary chemical treatment in a bag.

The British Army at the outbreak of the first World War, 1914, used a modification of the Berkefeld Filter in the field. The French tried sterilization by ultraviolet light, but the apparatus was clumsy, heavy and fragile. The Germans devised a rather successful method of chemical sterilization by means of the use of antiformin (a solution of sodium hypochlorite made stable by the addition of sodium hydroxide). Liberated chlorine caused the purification of the water.

The use of chlorine for the sterilization of drinking water is the well accepted method, of the widest general use. The problem is how to deliver a sufficient amount of the chlorine into the water to be purified. For the treatment of small amounts of water there has been no better device perfected than the Lyster Bag, known to all who have been American soldiers in the present century. This device was developed by Major William John L. Lyster, now Colonel, retired. It is officially known in the Army as the "Bag, Water, Sterilizing." It consists of a specially woven flax bag, sewn into a galvanized iron ring, hinged so that it folds in one diameter. The bag is suspended from poles and has a capacity of 36 gallons. Calcium hypochlorite is used in the process of treatment of the water. More recently high-test hypochlorite has been provided for use in the Lyster Bag, a compound that is more stable and which releases a greater percentage of chlorine.

Liquid chlorine in water purification was first employed by Major (later Brigadier-General) Darnall, the inventor of the Darnall Filter above described, in 1910. This method is now used throughout the world and one is glad to note that General Darnall lived long enough to receive merited recognition for his priority. His experimental work, upon which the method is based, was done at the Army Medical School where he was then Professor of Chemistry, and of which he subsequently became Commandant. General

[4] Comrie, J. D. History of Scottish Medicine. 2. ed. 2 vols. London, Wellcome Historical Medical Museum, 1932. Vol. 1, p. 317.

Darnall's priority in this use of liquid chlorine is attested by basic patents in this as well as other countries, the validity of which has been upheld in the courts.

In 1922 Lieutenant-Colonel (then Major) Arthur Parker Hitchens described a simple mode of purifying drinking water under emergency conditions by the use of ordinary seven per cent tincture of iodine in the Lyster bag or similar container. Five cubic centimetres of this tincture will render a Lyster bagful of water safe. The possibility of use of iodine in this form constitutes an important substitute for the bleaching powder ordinarily used, and which may not always be available. (*Military Surgeon*, 1922, **51**, 657–662.)

"AMERICA'S GREATEST GIFT TO MEDICINE": THE ARMY MEDICAL LIBRARY AND ITS INDEX-CATALOGUE

Superlatives are dangerous things, yet when used by a man of accepted preëminence they cannot be disregarded. The following incident is an illustration.

Not long before his last illness, Dr. William Henry Welch (1850–1934) paid a visit to the Army Medical Library, or the Library of the Surgeon General's Office, as it was always known prior to 1922. He was one of the Library's oldest friends and most constant users. As he sat in the Librarian's office smoking one of his black cigars, he fell into one of those reminiscent moods which his friends and pupils so enjoyed. He spoke of the foundation of the Library, of its growth, of the place it occupies in the world of science, and then said:

"I have been asked on more than one occasion what have been the really great contributions of this country to medical knowledge. I have given the subject some thought and think that four should be named: 1. The discovery of anæsthesia. 2. The discovery of insect transmission of disease. 3. The development of the modern public health laboratory, in all that the term implies. 4. The Army Medical Library and its Index-Catalogue. And [he added slowly] this library and its catalogue are the most important of the four."

The Librarian was so struck with this pronouncement that he reduced it to writing immediately after Dr. Welch left. I bear witness, for I was the Librarian.

This was not Dr. Welch's first statement of this kind. In 1927 he wrote: "I question whether America has made any larger contribution to medicine than in building up and developing the Surgeon General's Library and in the publication of the *Index-Catalogue* and the *Index Medicus*."

The Army Medical Library was created in 1836 by Surgeon General Joseph Lovell (1788–1836) and was at first merely a small collection of books for the use of the Surgeon General and his staff, hence its early name, Surgeon General's Library. It grew slowly. Its first catalogue (1840) listed but 228 volumes. This little pamphlet when placed beside the fifty-four ponderous tomes of the *Index-Catalogue* forms the most eloquent monument to the genius of Billings, as we shall see. It is "Billings' float down to posterity," as Osler put it.

In 1868 the sum of $80,000 left over from hospital funds of the War Between the States was turned over to Assistant Surgeon John Shaw Billings (1838–1913) by far-sighted Surgeon General Barnes, and Billings embarked on the mighty task of gathering the world's greatest collection of books. There is not space here to review in detail his remarkable career and his great success in adding books. The collection in his lifetime was one of the most important and today is unrivaled, being the largest collection of medical literature that has ever been gathered together.

Billings, probably the greatest medical officer our Army has ever had, realized early in his work that a collection of books without an adequate catalogue is like a tool without a handle. He did not consider mere printed lists of books sufficient, though most libraries had nothing more. After nearly fifteen years of study and experiment, including communication with the world's greatest clinicians and writers, he produced the first volume of the *Index-Catalogue*, containing, in one alphabet, subjects and authors with the initial A. In this one volume it was quickly possible to find anything needed if beginning with the letter A. The appearance (1880) of this volume marks an epoch in the development and improvement of medical literature. It has no equal. "Its preparation," said Osler, "is Gargantuan." In no other field of knowledge is there a work comparable to this, the world's standard of medical bibliography.

In the following year the second volume appeared, containing the material and authors beginning with B. Thus year after year additional volumes were published until the end of the alphabet was reached in 1895. At this time

Billings left the library and was succeeded as Librarian by Colonel David Low Huntington (1834–1899), who had been in charge of the monumental *Medical and Surgical History of the War of the Rebellion*. Billings did other great things too and some of them are noted elsewhere.

On the completion of the First Series of the *Index-Catalogue*, a Second Series was begun, the volumes appearing at the same rate of about one per year. The Second Series supplements, but does not duplicate material in the First. The Second Series, twenty-one volumes, was published from 1896 to 1916. A Third Series, ten volumes, was published from 1918 to 1932. The Fourth Series began in 1936 and the sixth, or G, volume is already published (1941). And the work goes ever on. The volumes are as much in use abroad as at home and in any great medical library of the world it is this mighty work that one must consult in extensive use of medical literature.

Since it takes approximately a quarter-century to complete a series of the *Index-Catalogue*, Billings realized that an additional publication was needed. He therefore created the *Index Medicus*, a periodical (at first monthly, then bi-monthly and finally quarterly) to give the entire current medical literature for the period. This younger sister of the *Index-Catalogue* is a valuable supplement and is in equal general use. Unlike the *Index-Catalogue*, the *Index Medicus* was never a Government publication and has always had a hard financial career. It was issued by one publisher after another but all withdrew because of the loss. The work, as the late Paul Hoeber, the publisher, put it, "had countless users but few subscribers." At length the Carnegie Institution published it, but finally they too had to let it go and it was finally consolidated with the *Quarterly Cumulative Index* of the American Medical Association, being now known as the *Quarterly Cumulative Index Medicus*.

There is not space to dwell on the treasures of the Army Medical Library. Its collection of rare books is by far the best in America and one of the most extensive in the world. It is estimated that there are about 600 medical incunabula (books printed before 1501) in existence. The Army Medical Library has 486 of them. It has a more complete series of theses of the University of Paris than that institution has itself. It subscribes to nearly everything published in medicine, receiving works in some sixty languages. In the *Index-Catalogue* it performs what sounds like the impossible: It indexes *every* article in *every* issue of *every* journal from *every* country. Of course this does not take into consideration unimportant local or trade journals.

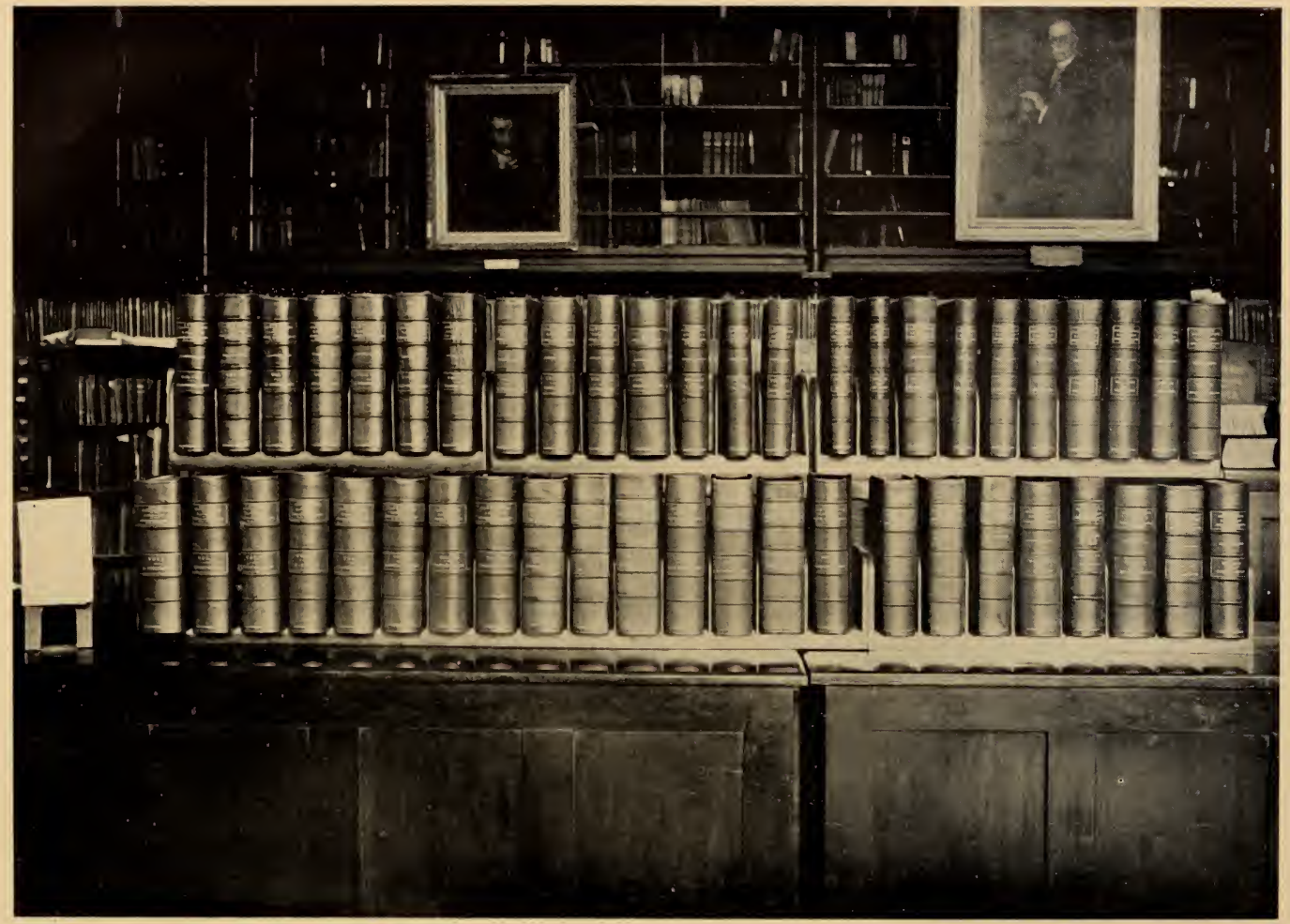
In 1936 the Library celebrated its centenary. From many universities and libraries at home and abroad came delegates and messages to honor the occasion. The oration was delivered by Sir Humphry Rolleston, Baronet, at one time Regius Professor of Physic at Cambridge. Sir Humphry reviewed the Library's history, confirming what is said above, and paying warm tributes to Billings, Dr. Robert Fletcher (1823–1912), his associate and long editor of the *Index Medicus*, and Colonel Fielding Hudson Garrison (1870–1935), who was for a generation associated with the library. Though never Librarian, he wrote his great *Introduction to the History of Medicine* while on this duty and many another contribution to medical history. He later became the first Librarian of the Welch Medical Library of Johns Hopkins.

The present building of the Army Medical Library, including the Army Medical Museum, was erected in 1887 and has long since been outgrown and outmoded. It is filled to overflowing. During the administration of Surgeon General Reynolds, and through his initiative and efforts, Congress passed an Act authorizing the construction of a new building. Subsequently a part of the necessary funds was made available, but with the second World War in progress it seems likely that the new building must await the end of hostilities.

One may sum up the world's opinion of the *Index-Catalogue* in the words of Professor William Bulloch, F. R. S.: "Among catalogues the Surgeon General's is regarded by the authorities of the British Museum as the greatest ever achieved. It has the great virtue of being a subject index, unlike that of the British Museum, which is a name index only."[5]

This is probably the most appropriate place to mention a few other facts about the remarkable career of Colonel Billings. He was uniformly successful. He designed the Johns Hopkins and Peter Bent Brigham Hospitals. He was Professor at the University of Pennsylvania (where he was first in charge of the Phipps Institute) and at Johns Hopkins. He was in charge of the vital and social statistics of the Tenth and Eleventh Censuses.

[5] *British Medical Journal*, 1935, **2**, 810.



Some Fifty Volumes of the Index-Catalogue Contrasted with the Pamphlet Catalogue of 1865 (*at left*). Taken together, the two serve as Billings's most eloquent memorial.

His report had much to do with transforming the old Marine Hospital Service into the splendid modern U. S. Public Health Service. He created and directed the New York Public Library. He was active in the organization of the Carnegie Institution at Washington. He held honors from many learned societies and universities of many lands. He was, said Garrison, with the possible exception of another military surgeon, Dr. Silas Weir Mitchell (1829–1914), the best known American physician to Europeans.

In Billings's address, the best he ever wrote, delivered in 1881 before the International Medical Congress in London, he said: "If the entire medical literature of the world, with the exception of that which is collected in the United States, were now to be destroyed, nearly all of it that is valuable could be reproduced without difficulty." The importance of the Army Medical Library, then in its infancy, could hardly have been better expressed. It has grown steadily and greatly, realizing the hopes and dreams of generations, as if in the words of Goethe's *Chorus Mysticus*, the unattainable had at length become a reality.

ARMY MEDICAL MUSEUM, THE WORLD'S LARGEST

The sister institution of the Army Medical Library, and one almost as well known, is the Army Medical Museum. It was created by Surgeon General William Alexander Hammond (1828–1900) in 1862 for the primary object of collecting and preserving specimens illustrating wounds and diseases causing death and disability in the Army, in order that study might lead to reduction in mortality. Gradually the collection was extended to include all pathological specimens. The Museum grew rapidly. As early as 1870 Bérenger-Féraud stated that "the United States has done as much in the matter of an anatomical-pathological museum in five years as has been done in all of Europe in a century."[6]

Though its first specimens were largely from Civil War battlefields, the civilian physicians of the country soon began to contribute specimens, and the institution grew apace. In 1874 Sir John Eric Erichsen, in a lecture at the University College Hospital, London, said: "There is one museum which is so unique, so admirably arranged, and so interesting. . . . It is the Museum of the Army Medical Department in Washington. This magnificent collection illustrating not only every possible variety of gunshot and arrow injury, but also those diseases which are more fatal than the bullet to an army in field or in camp. . . ."[7]

The Museum has received an enormous amount of material from a wide variety of sources, both civil and military. The Army's Tropical Board has sent in its material. Special facilities were made for the collection of material from the theatres of war during the Spanish-American and first World Wars. Similar facilities exist for the present war. Both gross and microscopic material is on display and available for study. One of the most interesting features is the collections of historical material, such as the unrivaled collections of microscopes, of ophthalmoscopes, aids for the deaf, etc.

The Museum is not merely a place where interesting specimens are displayed. Its rich material is made available for study both at the institution itself and on loan.

Its extensive facilities are available for aid to military, and to a more limited extent, civil physicians as well, in diagnosis. The study of specimens to determine the nature of supposed malignancy is one of the important routine duties of the Museum. Its staff also identify insects, helminths, etc. Its photographic laboratories are unexcelled.

A number of the more important clinical societies of the country place their entire pathological collections in the Army Medical Museum for safekeeping, display and study. Thus the museum is a central point for exchange of information and ideas. This is regarded by the Curator as one of the Museum's most important duties at present. There have been established eleven *Registries*, as they are known, great collections of pathological material and written descriptions and studies thereof. The Registries with dates of establishment are: (1) Research files of the International Association of Medical Museums (1922); (2) Registry of Ophthalmic Pathology by the American Academy of Ophthalmology and Otolaryngology (1922); (3) Registry of Otolaryngology by the same (1935); (4) Lymphatic Tumor Registry of the American Association of Pathologists and Bacteriologists (1925); (5) Bladder Tumor Registry of the American Urological Association (1927); (6) Registry of Oral and Dental Pathology of the American Dental Association (1935); (7) General Tumor Registry of the American Society of Clinical Pathologists (1937); (8) Skin Registry

[6] *Cor.-Bl. d. alg. ärztl. Vereins v. Thüringen*, 1876, **5**, 81.

[7] *Lancet*, 1874, **2**, 720.

of the American Dermatological Association (1937); (9) Kidney Tumor Registry of the same association (1938); (10) Chest Tumor Registry of the American Society of Thoracic Surgeons (1940); (11) Registry of Neuro-pathology (arrangements now being completed).

These splendid collections include more than 1100 eye specimens, 1500 specimens in otolaryngic pathology, 2500 dental and oral specimens, 1100 lymphatic tumor specimens, 680 general tumors, 500 kidney tumors, 1000 skin specimens, and 150 chest tumors. These data are to the middle of 1941 and all collections have grown steadily. On 9 April 1942 the Museum announced the formation of an extensive collection of photographs of war wounds.

Here then we have unrivaled collections of material which is available to the entire medical profession of the nation and of the world. This is a splendid example of the work done by the Army Medical Department for the general public.

Appreciation of the Army Medical Museum is no new thing. Writing of Surgeon General Hammond's career, Dr. Silas Weir Mitchell (1830–1914) said: "Whatever else may be said of William A. Hammond, nothing is more sure to me than that he duly saw and grasped a great opportunity; that he served his country as few could have done; that he created the Army Medical Museum; that he saw the need for and advised the creation of the Army Medical School; that he pointed out the men who were to direct the Army Museum and Army Library. Until the end of his career he was the unfailing friend of scientific study, and created special hospitals for diseases of the heart, lungs and neural maladies." (*Scientific Monthly*, May, 1917, 413.)

THE FIRST AMERICAN BACTERIOLOGIST

When asked to prepare the epitaph for the monument of Surgeon General Sternberg, Professor William Henry Welch wrote:

"Pioneer American Bacteriologist. Distinguished by his studies of the causation and prevention of infectious diseases, by his discovery of the microorganism causing pneumonia, and scientific investigations of yellow fever, which paved the way for the experimental demonstration of the mode of transmission of this pestilence. Veteran of three wars, brevetted for bravery in action in the Civil War and the Nez Percés War. Served as Surgeon-General of the U. S. Army for a period of nine years, including the Spanish War. Founder of the Army Medical School. Scientist, Author, and Philanthropist, M.D., LL.D."

The statement of Dr. Welch cannot be gainsaid. Sternberg was the father of bacteriology as known in the United States. He became interested in the new science at its very beginning. In 1881 he discovered the pneumococcus, the pathogenic agent of lobar pneumonia, which he found to be constant in his own sputum. It was found to be identical with the organism described by Pasteur earlier in the same year. Later, 1885, Sternberg demonstrated that his *Micrococcus pasteuri* is in fact the capsulated micrococcus found in the rusty sputum of pneumonia patients. While Fränkel is entitled to credit for this important discovery, it was Sternberg who first recognized and described the organism.

In 1882, while on duty at Fort Mason, California, Sternberg demonstrated and photographed, for the first time, the tubercle bacillus, which had been discovered in that year by Koch.

Sternberg's work on yellow fever has been mentioned under that title.

His textbooks on bacteriology played a most important part in the development of that science in the United States. In 1880 he translated Antoine Magnin's *Les Bactéries* (1878) from the French. In 1884, under the authorship of both Magnin and Sternberg, this work was greatly enlarged and brought down to date (480 pages, including 152 pages of Magnin's work). In 1892 there appeared Sternberg's *A Manual of Bacteriology*, which in 1896 was revised as *A Text-Book of Bacteriology*. Many of his own photomicrographs illustrated both books. Thus did Sternberg write America's first textbook on bacteriology, a milestone indeed.

THE MEDICAL DEPARTMENT FOUNDS AMERICAN METEOROLOGY

In no other field not directly connected with medicine have United States Army medical officers done more outstanding work than in meteorology. The United States Weather Bureau owes its origin to the Medical Department of the Army and one of the most outstanding American meteorologists was one of our officers.

The first official meteorological records in America began with the order of Dr. James Tilton (1745–1822), Physician and Surgeon General of the Army, who on 2 April 1814 directed hospital surgeons to record the weather. This was the

beginning of systematic American meteorological observations. Tilton was a veteran of the American Revolution, having served successively as Surgeon of the Delaware Regiment (1776), Hospital Physician (1777) and Hospital Physician and Surgeon (1780), and in this last capacity to the end of the war. He is the same Tilton who first saw the dangers of overcrowding, as related presently. Tilton became first President of the Delaware Society of the Cincinnati and from 1785 sat in the Continental Congress. He was appointed Physician and Surgeon General of the United States Army in 1813 and served as such through the War of 1812.

Tilton is of course entitled to the credit for initiating the recording of data anent the weather, but with the War of 1812 in progress and Tilton himself in the field with the Army in the North, efficient compliance with his orders in this regard was impracticable, so it fell to his successor to carry out the idea. Tilton is often forgotten in praise of those who followed him in office, and who continued the requirements he had first laid down.

Even before Tilton's time several incomplete series of unofficial records of the weather had been kept. Rev. John Campanus of the Swedes' Fort near Wilmington, Delaware, recorded data from 1644 to 1645. Chief Justice Peter Dudley of Massachusetts kept records in Boston, 1729–1730. Dr. John Lining kept similar records at Charleston, South Carolina, 1738–1750. Benjamin Franklin in 1739 kept systematic notes of the weather and ocean temperature during his return voyage from England. Prof. John Winthrop of Harvard College kept regular meteorological records from 1742 to 1778. Thomas Jefferson kept such records at his home, Monticello, Virginia, between 1772 and 1777. But of course all these records were incomplete and not extensive.

Surgeon Benjamin Waterhouse (1754–1846), better known for his introduction of vaccination into America, was also a pioneer meteorologist. The earliest meteorological journal in the Army Medical Library is dated Cambridge, Massachusetts, July 1816. On the first page is written:

"Among the rules for the medical staff of the Army of the United States is that which makes it the duty of each hospital surgeon and director of a department 'to keep a diary of the weather, together with an account of the medical topography of the country in which he served.' Wherefore the following sketch of Boston and its vicinity, and particularly of Charlestown, is offered to the commander in chief, Major General [Jacob] Brown, by Benjamin Waterhouse, M.D., hospital surgeon and director of Department No. 2, Northern Division, as a first step in fulfilling this desideratum. Cambridge, July, 1816."[8]

The unpublished meteorological records of the Army Medical Department extend to 1820.[9]

With the reorganization of the U. S. Army in 1818 the meteorological observations made by Army medical officers were greatly extended. Secretary of War John C. Calhoun is sometimes given credit for pioneer work in this field. It was the Surgeon General who directed that this work be carried forward. That officer was Dr. Joseph Lovell (1788–1836) of Massachusetts, whose vivid account of his experiences in the War of 1812 is found in Mann's *Medical Sketches*.

Surgeon General Lovell issued the following instructions:

"Every physician who makes a science of his profession, or arrives at eminence in it will keep a journal of this nature, as the influence of the weather and climate upon diseases, especially epidemics, is perfectly well known. From the circumstances of the soldier, their effects upon diseases of the army are peculiarly interesting, as by proper management they may be in a great measure obviated. To this end every surgeon should be furnished with a good thermometer, and, in addition to a diary of the weather, should note everything relative to the topography of his station, the climate, complaints prevalent in the vicinity, etc., that may tend to discover the causes of diseases, to the promotion of health, and the improvement of medical science."

From this time forth careful meteorological data have been recorded and the records of the Weather Bureau go back thus far, making use of these observations by Army medical officers.

The first publication on meteorology by the Medical Department of the Army appeared in 1826 under the title: *Meteorological Register for the Years 1822, 1823, 1824 and 1825, from Observa-*

[8] Topographical-medical Remarks, together with Meteorological Tables, or a Diary of the Weather, made near the Headquarters of the 2d Military Department, by Benj. Waterhouse. (Ms. in the Army Medical Library.)

[9] Cf. International Meteorological Congress, Chicago, 1893. *Report.* Vol. 2, p. 208. Washington, 1894. (Forms no. 11, Weather Bur. Bull.)

tions made by the Surgeons of the Army, at the Military Posts of the United States. Prepared under the Direction of Joseph Lovell, M.D., *Surgeon-General of the United States Army, Washington, 1826.* The meteorological tables in this volume served as a contribution to the solution of the question of whether, in a series of years, there is any material change in the climate of a country, and, if so, how far it depends on the cultivation of the soil, density of population, etc.

Lovell was succeeded in office by the colorful Surgeon General Thomas Lawson (1781–1861) of Virginia, a distinguished medical officer who held office for twenty-five years, 1836–1861—longer than any other man. He accompanied General Scott in the invasion of Mexico and received the first brevet of brigadier-general ever given to a medical officer.[10] Under Lawson's direction the Army Medical Department published the second (1826–1830), third (1831–1842) and fourth (1842–1854) *Meteorological Registers*, all classical works of reference.

During this same period the Army Medical Department was making other studies of the effect of climate and weather on human beings. In 1840 Surgeon General Lawson published the *Statistical Report on the Sickness and Mortality in the Army of the United States, compiled from the Records of the Surgeon General's and Adjutant General's Offices, 1819–1839.* Two years later Assistant Surgeon Samuel Forry of Pennsylvania published *The Climate of the United States and its Endemic Influences*, New York, 1842. This work, a milestone in American climatology, was followed by others from Forry's pen.

In 1842 Congress appointed another Pennsylvanian, James Pollard Espy (1785–1860), meteorologist to the War Department, where he continued the excellent work begun by Forry. Professor Espy was one of the foremost meteorologists of the world. He laid the foundation of weather forecasting by the institution of telegraphic bulletins giving knowledge at one place of the correct state of the weather at various widely different locations. Espy, though never an officer of the Army Medical Department, was directly responsible to Surgeon General Lawson, whose intelligent support made his work practicable. Lawson's wise policy was to coöperate closely with other scientific bodies interested in meteorological recording, including the Smithsonian Institution, the Franklin Institute and the American Philosophical Society.

In 1856 Surgeon Richard Henry Coolidge of New York published a *Statistical Report on the Sickness and Mortality of the Army of the United States, Compiled from the Reports of the Surgeon General's Office*, 1839–1855. Here, again, we have an important work on vital statistics which considers the effect of climate and weather on man.

The best known meteorologist of the Medical Department of the United States Army is Surgeon Albert James Myer (1828–1880) of New York, who became the first Chief Signal Officer of the Army and founder of the Weather Bureau. For him Fort Myer, Virginia, across the Potomac from Washington, is named.

Myer, while stationed in the Indian country in 1858, became interested in the system of beacon lights and smoke signals used by the Indians to send messages from hill and mountain tops. A result of his studies was a system of signalling by flags in the daytime and by torches at night, which became a most useful practice during the War Between the States. In 1862 he was placed in charge of the Signal Office in Washington and there served for the remainder of the war. When the Signal Corps was created as a separate branch of the Army, Myer was the logical choice for its chief. Limitations of space preclude a full account of Myer's most distinguished service. He established stations throughout the country where storms could be observed and data recorded. The *Farmers' Bulletins* of the Weather Bureau, the storm flags on Post Offices and elsewhere were two of his measures. He recorded the stages of the water in rivers and harbors and issued bulletins from time to time warning the public as to floods to be expected.

During the time that he was doing all these things Myer still held his commission as an Army medical officer. In 1870 the Signal Service was created, and in 1890 the Weather Bureau, long a goal of Myer's recommendations. Medical officers of the Army did not cease to keep meteorological data, however. It was generally continued until after the Spanish-American War and in some stations long thereafter. At the United States Military Academy, West Point, the Surgeon was responsible for this work until 1927![11]

[10] Ashburn, P. M. A History of the Medical Department of the United States Army. Boston and New York, Houghton Mifflin, 1929. P. 66.

[11] Ashburn, *op. cit.*, p. 388.

Much could be written about the special studies of meteorology and climatology made by U. S. Army medical officers. The Surgeon Generals who succeeded Lawson consistently gave their support to this work, the last having this responsibility being Joseph K. Barnes (1817–1883) of Pennsylvania, the medical officer who had the duty of attending two Presidents of the United States, Lincoln and Garfield, when struck down by the assassin's hand.

Other medical officers who have written important works on meteorology and climatology are Surgeon Joseph Janvier Woodward (1833–1884), who at the International Congress of Medicine in Philadelphia, 1876, reported the work that he and his colleagues of the Medical Department of the Army were doing in meteorology;[12] Dr. George Martin Kober (1850–1931), loyal son of the Army Medical Department and dean of the Georgetown University Medical School, has told of his own and his colleagues' experiences.[13] Most recently Brigadier-General Edward Lyman Munson, Assistant Surgeon General, has written a number of climatological papers and has an extensive work on the medical side of this science soon to be published.

Thus may the Medical Department claim to have contributed greatly to the welfare and comfort of the nation's population by these early and continued studies of weather and climate and their bearing on the lives of all.

PUERTO RICO FREED FROM HOOKWORM DISEASE

In 1899 Colonel (then First Lieutenant) Bailey Kelly Ashford (1873–1934), Medical Corps, U. S. Army, began his studies of what was then called "*Porto Rican anæmia*" or "*tropical chlorosis.*" He soon determined that it was due to infestation by a hookworm. Ashford, while a student at the Army Medical School, had heard from the Professor of Helminthology, Surgeon Charles Wardell Stiles (1867–1941) of the Public Health Service, of the anæmia that may be produced by hookworms. He showed that the parasite in the Porto Rican anæmia was the New World type, *Necator americanus.*

Written in his characteristically breezy style, Ashford's own account of his finding the hookworm in Puerto Rico is worth quoting:

"But who had ever heard of a whole agricultural class dying of an *epidemic* of *pernicious anaemia*? It was unthinkable. Hold on! Look at these eosinophiles. What were they doing, so numerous, in pernicious anaemia? . . . Oh, yes, now I remember something I read out of a journal not long ago. A man by the name of Brown[14] found these prominent strawberry-looking eosinophiles to be increased in an infection by the worm causing pork measles. Maybe these anemics have worms! And I began to laugh; . . . but I sat up far into the night, until the chilly morning land breeze began to blow. And I went to bed still intrigued, with eosinophiles shooting like comets before my eyes. The idea that a frightful epidemic anemia with a high death rate might be caused by anything so commonplace as worms!"[15]

Ashford also gives the results of his deliberations and studies by quoting a telegram:

> "Ponce, November 24, 1899
> Chief Surgeon, San Juan:
> Have this day proven the cause of many pernicious, progressive anemias of this island to be due to Ancylostomum duodenale.
> Ashford."[16]

As a result of Ashford's findings and recommendations, a campaign was inaugurated in the newly acquired island of Puerto Rico, and the inhabitants by tens of thousands were treated successfully. This was a splendid accomplishment in medical science and in national hygiene. Though less dramatic than Gorgas's work in Cuba and Panama, it was worthy of consideration in the same light. Ashford's work has now been duplicated in many countries, particularly by personnel of the Rockefeller International Health Board.

AMERICAN VITAL STATISTICS FIRST KEPT BY THE ARMY

The Medical Department of the Army kept the first reports upon which American vital statistics are calculated. In the days of our country's beginnings military records were scanty at best

[12] *Trans. International Med. Congress, Phila., 1876.* Phila., 1877. Pp. 286–304.

[13] *Military Surgeon*, 1929, **65**, 65–83.

[14] Thomas Richardson Brown, head of the Division of Digestive Diseases at Johns Hopkins. The paper is: Studies on Trichinosis, with especial reference to the increase of the eosinophile cells in the blood and muscles, the origin of these cells and their diagnostic importance, *J. Exper. Med.*, 1898, **3**, 315–347.

[15] Ashford, B. K. A Soldier in Science. N. Y., Morrow, 1934. Pp. 42–3.

[16] *Ibid.*, p. 5.

and often little or no record of soldiers was kept. Ask the eager ladies who seek membership in hereditary societies based on the military services of their ancestors in our early wars! They know to their sorrow how little the records reveal. But some of the first holders of the office that corresponds to Surgeon General of the Army today required such records to be kept by their officers. For this and other reasons the Annual Reports of the Surgeon General of the Army are prized reference works.

In 1857 there was published *Medical Statistics, United States Army.* This was really Part I, of which Part II appeared in 1859.

In 1875 Colonel Jedediah Hyde Baxter (1837–1890), who later became Surgeon General, prepared a report of *Medical Statistics of the Provost Marshal General's Bureau.* This was in reality a vital statistical study.

In 1895 the Medical Department adopted the new international system of statistical reports.

Billings, among his many other accomplishments, must be regarded as one of the most skillful statisticians of his day. He was familiar with the mathematical methods of Körösi, Rumsey, Farr, and the other predecessors of Karl Pearson. He took an active part in the work of the Bureau of the Census, and between 1878 and his death in 1913 he was one of the leaders in this field. Veritable monuments are his careful vital and medical statistics in connection with the Censuses of 1880, 1890, and 1910. Had he never done anything else of note his place in the annals of vital statistics would be secure.

In his Cartwright lectures he told something of his methods and of the work done under his supervision. These lectures were delivered in 1889 before the College of Physicians and Surgeons of New York. In his statistical reports he employed the usual methods of interpretation, applying statistical induction to establish new data as to racial equation and racial incidence of disease.

With the new statistics of Karl Pearson, which employed advanced mathematics in the interpretation of correlations, Billings, according to Garrison, was not familiar. Nevertheless the final paragraphs of his Cartwright lectures reveal Billings's appreciation of the fallacies and inadequacies of the older methods. He seemed to gaze into the future and saw there something of the methods to come. Here is a quotation:

"In vital statistics, as in other branches of social science, it is not true that the effects of causes acting in combination are equal to the sum of the effects of each of the causes acting separately. Different causes of death having no relation to each other do not have a joint effect which is equal to the sum of the effects of each cause taken separately, and it is therefore difficult to bring the phenomena of vital statistics within the boundaries of mathematical formulæ. In the doctrine of this kind of averages, time and number are not convertible terms. . . .

"In studying medical and vital statistics one is somewhat in the position of a man on the deck of a large Atlantic steamer out of sight of land and gazing on the troubled ocean. He sees many waves, large and small, apparently moving in every direction; and it is not until he has, by careful examination and repeated comparison, learned to distinguish the ripples due to the wind now blowing, the larger cross seas resulting from forces which were acting a few hours before, and the long, rolling swells which indicate to some extent the direction and force of the tempest of yesterday, that he can begin to understand the roll of the ship on which he stands; while to appreciate the force and direction of the great current which is sweeping with it all the troubled water and the ship itself, requires skilled observation with special instruments, and the use of charts which embody the experience of hundreds of voyages. So also in viewing the records of human life, disease, and death, the variations which are at first most perceptible are often those which are most superficial, and which give little or no indication of the magnitude and direction of the movement of the great masses beneath." (Garrison's Memoir of Billings, 334)

In 1880 Billings suggested that the various statistical data of the living and the decedent "might be recorded on a single card or slip by punching small holes in it, and that these cards might then be assorted and counted by mechanical means according to any selected group of these perforations."

This suggestion was carried out by Mr. Herman Hollerith in the electrical counting and integrating machines which are now used by the United States Census and many other public and private institutions, including the office of the Surgeon General of the Army.[17] In his address to the International

[17] Cf. J. S. Billings, *Proc. Am. Assoc. Advancement of Science*, 1891, **40**, 407–409.

Congress of Medicine at Philadelphia, 1876, Surgeon Joseph Janvier Woodward (1833–1884) stressed the importance of the Army's records of morbidity and mortality, and listed some of the *Circulars* of the Surgeon General's Office pertaining to such records. Among them was his own: *Sickness and Mortality of the Army During the First Year of the War*, *Circular* No. 9, Surgeon General's Office, 9 September 1863.

The Medical Department of the Army has produced a number of officers who have been interested in vital statistics, but of the moderns only one has proven his worthiness to be classed with the great Billings. This officer is Brigadier-General Albert Gallatin Love, who has reported at length and exhaustively on the vital phenomena concerned with the drafted men who were brought into the service for the World War. He has written numerous papers.

The Army, mindful of Love's long and valuable work, promoted him Brigadier-General in 1939. He was in charge of the Division of Training in the Surgeon General's Office until his retirement in 1941. He has been placed on active duty and is now collecting data for a future history of the Medical Department in the present war. No more happy selection than this could have been made, and thus will the Army have material collected before too much has to be trusted to memory.

VENEREAL DISEASE CONTROL

Venereal diseases are as old as armies, though it is only in modern times that the nature of such maladies has been known. A great British military surgeon, John Hunter (Deputy Surgeon General, 1786), thought that he had proved that syphilis and gonorrhœa are the same disease, because in infecting himself with what he thought was one he contracted both. It was only in 1879 that Neisser showed that these two diseases are distinct. A decade later Ducrey discovered the causative organism of chancroid.

But the Army's war against venereal diseases began long before they were understood. In 1778, upon the recommendation of the senior medical officers, Congress passed an Act subjecting any officer who entered a hospital for the cure of venereal disease to a fine of ten dollars. Similarly, soldiers were fined four dollars. The money thus obtained was used for the purchase of blankets and shirts for the soldiers who were sick in hospital. Unfortunately the incomplete records of the period give us no idea of the results of this early attempt at prevention.

During the War of 1812 the War Office tried more or less the same measure. The following order was issued: "No noncommissioned officer, musician or soldier of the Army, being a venereal patient, shall receive pay while under cure, and deduction shall be made from his wages for the amount, in price, of all medicines administered to him during the period of his being so diseased."

In May of 1814 the War Office issued another memorandum, stating: "Women infected by venereal disease shall in no case be allowed to remain with the Army, nor draw rations." Elsewhere it was announced by the War Office: "More than five women shall not be allowed to a company, when organized and completed agreeably to the establishment. Nor shall any be allowed to accompany recruiting parties which shall be fewer than seventeen men nor shall more than one accompany parties of that number. No contractor or commissary shall be justified in issuing rations to women, who are followers of the Army, beyond the number allowed by law."

There was a marked reduction in incidence of venereal disease from 1819 to 1846, so possibly these regulations had some effect. However, the military service has long since decided that this is not the best way to attack the problem. The presence of women camp followers was an old evil, and one which military men had long recognized. The German leaders in the seventeenth century forbade women in camp unless they were duly wedded soldiers' wives. But this only resulted in countless "drum-head marriages"; the wretched offspring thereof were doomed to fill brothels and prisons. Garrison called the women who followed armies a sort of sexual canteen, and thinks that venereal infection might have been less if the *Weibertross*, as the horde of women was called, had not been present and available. *Hors de combat* as a military term may have more than one pronunciation and connotation!

For many years we find little record of any serious attempt to reduce venereal disease in the Army. Of course among the civil population there was no thought of anything of the kind. Popular sentiment was against it on the belief that venereal infections were punishment for sin. That innocent people could become infected was beside the point.

An effort to curb the spread of venereal disease was made in 1863 by the commander of Union

troops in Nashville, Tennessee. He initiated a system of control of prostitution, by requiring the registration and physical examination of prostitutes, with hospitalization of those found infected. The system failed as all such attempts have failed, but at least the effort shows that commanding officers had come to realize that they were dealing with a preventable communicable disease, and that they were responsible for such prevention.

Between 1899 and 1912 medical officers tried many measures to prevent spread of venereal disease. Some experiments were more successful than others, but there was little concerted effort by the service as a whole. In 1902 the War Department announced, by direction of the President, to soldiers, particularly those serving in the tropics: "The only really efficient way in which to control the disease due to immorality is to diminish the vice which is the cause of these diseases. Excessive indulgence in strong drink is absolutely certain to ruin any man, physically and morally; while disease due to licentiousness produces effects which are quite destructive and even more loathsome." The circular continued by pointing out to officers their duty to set an example of temperance and clean living and stressing the importance of healty recreation, athletics, etc. The responsibility of all this was placed on the line officers, where it of course belongs.

In 1909 the Surgeon General published a circular:

"The attention of all medical officers is invited to the importance of making vigorous and sustained efforts to prevent the spread of venereal disease in the Army." It was shown that the rates had increased during the Spanish-American War. Several measures were enjoined: (1) organization of clubs and other recreational centers for soldiers; (2) formation of temperance associations among soldiers, the relationship between intemperance and venereal indulgence being well understood; (3) the early detection of cases of venereal disease by periodical physical examinations; (4) keeping all venereal cases under continuous observation and treatment until cured. To this end venereal registers were created which would be sent from station to station if the soldier were transferred; (5) instruction by lectures and informal advice; (6) approved measures of personal prophylaxis.

In the following year, 1910, the Surgeon General published another urgent statement: "The venereal peril has come to outweigh in importance any other sanitary question which now confronts the Army and neither our national optimism nor the Anglo-Saxon disposition to ignore a subject which is offensive to public prudery can long excuse a frank and honest confrontation of the problem. There is no reason to think that these diseases are beyond the reach of preventive medicine any more than other contagious diseases and their immunity from restriction must be attributed to the public disinclination to discuss them and legislate concerning them. It is now believed by most sociologists as well as sanitarians that the evil being primarily a social one can only be reached by a propaganda of public discussion and education, and that education in sexual matters and in the danger of venereal diseases should begin with the young and be carried on by means of all agencies of popular enlightenment. A number of state and municipal health authorities as well as private associations are now publishing and distributing literature on this subject. It is believed that the War Department cannot do better than adopt this general attitude and many of these methods, including a philosophical indifference to criticism on the part of self constituted censors of the public morals whose sensibilities are offended by a public discussion of these questions."

The practice of physical inspections of the men, announced in the above publication, is still in effect. However, they are made not periodically but at irregular and unannounced intervals.

In 1909 the so-called "K Packet" was placed in use. It consisted of a tube of mercuric ointment with added colloidal silver. Men received them gratis and instructions as to their use were included. They were not very successful, chiefly because there was no way to insure their use.

In 1911 Colonel (then Major) Deane Childs Howard first advocated compulsory chemical prophylaxis for those known to have been exposed to venereal infection. He tried the method first at his station and found it successful.

In 1912 War Department General Order No. 31 announced the requirement that soldiers who had been exposed to venereal disease report themselves to the "prophylactic station" immediately on return to camp or station, and then take the chemical prophylaxis. In the same year Congress passed an Act withholding the pay of men absent from duty on account of the effects of their own misconduct—in other words as the result of alcoholism or venereal infection. Later it was also

provided that men so infected, and who had not taken the prophylaxis, should be subject to trial by court martial. War Department General Order No. 45 of 1914 and No. 6 of 1923 gave the details of the requirement.

The admission of drafted men into the military service at the time of our entrance into the first World War brought home forcibly to the medical profession the far greater amount of venereal disease among the general population than had been suspected. The methods already noted were tried on a large scale and with excellent results.

In the American Expeditionary Forces, Dr. Hugh Hampton Young of Johns Hopkins, a Colonel in the Medical Reserve of the Army, was put in charge of the problem of fighting venereal disease. His success in this won him the Distinguished Service Medal. He based his campaign on seven measures: (1) Social hygiene, for the purpose of minimizing the number of contacts; (2) Prophylactic treatment, bi-weekly examinations to detect the cases; (3) Repression of prostitution by placing brothels out of bounds; (4) Reporting the source of infection, and dispensary treatment of the civil population; (5) Enforcement of laws relating to alcoholism; (6) Court martial for those contracting venereal disease; (7) Treatment of venereal disease within the organizations, in order to reduce loss of effective strength and to avoid making venereal disease an excuse for escaping duty.

Since the first World War the Army has continued its fight against venereal disease, having the hearty coöperation of the American Social Hygiene Association and many other bodies. The police too have usually been most helpful, for venereal disease control without the bounds of military reservations is a police matter. The U. S. Public Health Service, ordinarily in charge of extra cantonment zones, as they are called, have also helped in this work.

With the selective service law, at the outset of the present emergency, there was once more found that the incidence of venereal disease among the general population was large. It was even suggested that voluntary infections were made the basis of claims for disqualifying disability. This last problem is not entirely solved, but it seems likely that some men may be admitted to the service even though suffering from such infections, provided there is prospect of early cure.

The problem of venereal disease is a national one, and not merely confined to the Army. But the Army's contributions to control have been such that the whole country profits.

(*Part II will appear in the next, June 1942, issue*)

Memoir of J. P. Crozer Griffith*

By ALFRED HAND

IN THINKING of the different professions other than the one to which we Fellows owe our allegiance and chief sympathy, I have felt that two others were deserving of a bit of sympathy, one, that of the clergy, the other, that of portrait painters; they have much in common and their aims do not always conduce to popularity; the one group tells us what we are and portrays us as we should be; the other is commissioned to make as handsome portraits of us as we think we are, but they may see us as quite different from what our mirrors show us to be and their final results may not satisfy them or us or our friends. I have recently added to these two a third profession, that of the biographers who are, after all, a species of portrait painters.

But portrait painting whether with brush, oil and pigments or with words is not always easy, for two reasons, one of which was given by a writer of Holy Writ when he said "Now we see, as through a glass, darkly." (I have heard in explanation of his simile that the glass of his day was thin sheets of mica.) The other reason is that, as our renowned colleague whose excellent portrait hangs in the President's Room on the first floor of this building, the immortal Autocrat of the Breakfast Table, says, there are at least three personalities in any one individual such as John: John as he really is, John as he thinks himself to be, and John as he seems to be to another person.

I think it would not be hard to write a biography of an average man; there are plenty of stereotyped phrases from which selections could be made and so arranged as to make a fairly accurate and readable one to fit any average man. But our late Fellow, the preparation of whose memoir has been assigned to me by the Council of the College, was not an average man, he was much above the average in many ways. From his college course, in which he led his class in scholarship at graduation, all the way on to the publication of the fourth edition of his classical and best-seller "Textbook of Pediatrics" which appeared shortly before the end of his long and full life, Dr. John Price Crozer Griffith (or, as he always preferred to have it written, J. P. Crozer Griffith) was always prominent. So there has been an accumulation of material sufficient for an extended biography. It has therefore been a problem to select such features as would make a true likeness of his personality.

Although it has not been an easy task it has been, nevertheless, a very pleasant one to look back over my associations with him, which began in my first year after being graduated from the Medical School and developed into a steadily deepening and uninterrupted friendship. But before indulging in reminiscences let me refer briefly to his forbears, on whom he reflected so much credit and of whom he had much reason to feel justly proud.

The name Griffith is of Welsh or old British origin, David Griffith being the first of the line in America, coming to what is now York County, Pennsylvania in 1756, and Dr. Griffith was of the fourth generation born in this country. His immediate progenitor, the Reverend Benjamin Griffith, was left a full orphan at eleven years of age, his mother having died two weeks after he was born; Benjamin, after his father's death, was for one year under the care of a court-appointed guardian and then for a year he lived with a maternal uncle in Mechanicsburg, Pa., attending school and after school-hours helping in his uncle's general store. At thirteen years of age he decided to strike out for himself, so his uncle furnished him with a colt on which he made the journey of seventy-six miles alone to Baltimore. After some adversities, he had steady employment in a drygoods store until he was nineteen years old when he entered Madison (now Colgate) University from which he was graduated six years later a clergyman of the Baptist Church. His first work was as a Home Missionary at a salary of $400 yearly; in this work he took charge of a small gathering of people as a nucleus, increasing its numbers until it became an active church; from this he went to an old, established church in Philadelphia which was in a much run down condition; he increased its membership so much that it was soon able to move from its very plain building to a fine Gothic edifice it had built. During this

* Read before The College of Physicians of Philadelphia, March 6, 1942.

ministry he was also a member of the Publication Committee of the denomination and as his administrative ability was recognized, he was persuaded to become the Secretary of the American Baptist Publication Society to which he gave his whole time for the rest of his life, managing its affairs so well through the hard times of 1857 and the Civil War and increasing its influence in the Baptist Church over the whole country that it outgrew its small quarters in Arch Street and moved to a large building in Chestnut Street east of Broad Street.

On the distaff side the name of Crozer is found, suggesting a French origin and the records show that Dr. Griffith's ancestors were among those who left France in 1685 at the time of the Revocation of the Edict of Nantes which, to quote from the French Dictionary, *Petit Larousse, Illustré*, "led to the expatriation of a great number of the most active and best workers of the French Nation." Dr. Griffith's mother was the daughter of John Price Crozer, a member of the family whose name had been given to the town in which she was born and whose members have long been noted for ability and philanthropy.

After graduating from the College Department of the University of Pennsylvania as valedictorian of his class in 1877, Doctor Griffith did not at once enter on his medical course but was persuaded to take a commercial position with a promising outlook. One year in this satisfied him and he entered the Medical School of the University of Pennsylvania, receiving the degree of M.D. in 1881 and also with it that of PH.D., gained by the thesis he presented. A year as interne in the Presbyterian Hospital in Philadelphia was followed by one in private practice; then for three years he studied internal medicine in London, Berlin and Vienna, returning to Philadelphia in 1886. For the next five years his attention was given mainly to internal medicine, assisting both Dr. Pepper and Dr. Osler and becoming Instructor in Clinical Medicine in the University's Medical School and Professor of Clinical Medicine in the Philadelphia Polyclinic. Then in 1891 at thirty-five years of age he gave up those positions as the gate opened for him into the fertile field of pediatrics, in which he labored most industriously for practically half a century. His success in this field may be attributed in part to the long period of training in internal medicine. It may have been longer than necessary, made so by the fact that the gate did not open earlier into the new field. But, however present-day sentiment may view it, it does not, judging by the results, seem to have been time wasted. Pediatrics fifty years ago was well described as the speciality of the general practitioner, but with the tremendous advances since then in all branches of medical science, and in none greater than in pediatrics, the care of infants and children requires very decidedly special training; yet some of us still feel that it should rest on a broad foundation of general medical study, perhaps a little more so than is at present furnished.

So Doctor Griffith came into his new field not only well prepared, according to the standards of the time, but also with certain traits or characteristics without which he could not have done such splendid work. I do not know the best order in which to list these traits; his enthusiasm and industry might be grouped together as a double team guided by his rare judgment. This judicial temperament was one of his marked characteristics and had he gone into the legal profession he would have ranked high as a jurist; it was always interesting to see how persistently he would seek all the knowledge possible bearing on any medical problem before giving his opinion. Of the extent of his enthusiasm for pediatrics at the start I cannot speak definitely, but it was abundant three years later when our association became more intimate, especially with the foundation of the Philadelphia Pediatric Society, in which he with Dr. Frederic A. Packard, Dr. Edwin E. Graham and others were active. The expression of his enthusiasm was rather more of the intellectual type than of that seen and heard on the athletic fields, but for those who observed it, it was quite as cheering and much more lasting in its influence and it was of steady growth to the close of his life. In a conversation it was my privilege to have with him in his last year here he showed just as great interest in the progress of pediatrics as ever, saying that in his opinion some of the younger men were making a mistake in saying that the only field for advance now was that of physiological chemistry for he felt that there could be great improvement along the whole line. And his mind was always open to the new, which he greeted with careful thought, accepting it only if it seemed reasonable and not just because it was new. So it is just to classify him as a Conservative-Progressive even though the tremendous advances in pediatrics would tend to make us all Radicals of high degree (speaking scientifically, not politi-

cally); for he always continued his habit of orderly thinking exhibited from his undergraduate days. As an illustration of his mental equipment, he read Einstein's writings on relativity and was able to explain the theory in such a way that even I could get a faint idea of what Einstein is seeking. (Although I have recently heard that Einstein himself begins to admit that it will probably never be possible to write one equation that will explain the Universe.)

Dr. Griffith's industry, like his enthusiasm, was not of the intermittent or hectic type; the amount of work evidenced by his medical writings, in the form of magazine articles, sections in various Systems edited by others, his own books, coupled with all the demands on his time for teaching and attending to practice in and out of the hospitals, would suggest that he had little time for recreation; but he knew how to work and when to play, and also how to enjoy to the full his varied interests and hobbies, music, flowers, travel, general science, his Church. I was aware of his industry when I first came in contact with him in the Pediatric Society, but of recent years it has amazed me everytime I open his "Textbook" to see what a tremendous amount of reading he had done in the literature on children's diseases; in addition, it gives an impressive exhibition of his ability to pick out the important point from an article and to give it its proper interpretation in its bearing on the general subject. In this connection, equal credit is most gladly given, as I know Dr. Griffith would wish it, to our late Fellow (also one of my intimate friends and great helper) Dr. A. Graeme Mitchell, who was collaborator with Dr. Griffith in the earlier and coauthor in the two last editions.

Equanimity, that characteristic held by Osler to be so necessary to the members of the medical profession, was clearly present in Dr. Griffith. He was positive in his opinions and would defend them stoutly but at the same time he would grant to others the right of maintaining their opinions even though they differed from his. He was also placable so far as he could be conscientiously, but never giving in to what is now known as appeasement. He met the different events of life as a strong man should. In my early days of practice he asked me to help him in the care of his brother, who was succumbing to an attack of that Philadelphia plague of the early days of this century, typhoid fever; and some years later he called on me to aid him with his aged mother, to whom he gave such filial care, who was having enteritis with alarming attacks suggesting the Stokes-Adams syndrome; recovery followed, but after a few more years I received an urgent call one morning when Dr. Griffith could not be located, finding her in a severe anginal attack; he arrived while I was preparing a hypodermic injection, which we gave a moment before the end. He bore these sorrows with outward calmness as he also did the bereavement that came to him four years before his own death in having to part with the wife who had been his constant companion for fifty-five years of married life, the beauty of which was evident to their hosts of friends.

Dr. Griffith's equanimity was also shown in a very effectual way when one of those disappointments came to him to which Osler referred in that address which was so widely quoted in the newspapers with misplaced emphasis; after speaking of man's period of productive work, Osler added a wish that some way might be found to protect men from those disappointments, misunderstandings and, to them, cruel treatments that so often befall them in their seventh and eighth decades. When such an experience came to Dr. Griffith it was evident that he felt it keenly, but in discussing it with me he did not raise his voice nor indulge in epithets, his severest comment being, "It leaves a bad taste in the mouth". But all these experiences did not have an acidifying effect on him, for all through his eighth decade and the first half of the ninth he was always the same genial, cheerful, kindly gentleman as before.

In his later years he found great enjoyment in his suburban home at Devon in cultivating flowers and it gave him much delight to show visitors his garden with its large variety of blooms and one section of dahlias which had a deservedly wide reputation; it demonstrated an extensive knowledge of horticulture and a formal garden plan of his own creation in such excellent taste as is rarely seen.

Dr. and Mrs. Griffith were very generous in their hospitality and they had the faculty very desirable in hosts of making their guests feel at ease. They entertained frequently both at home and at orchestral concerts, for they were very fond of good music.

Dr. Griffith was an active, influential member of the Baptist Church, being officially connected with one of its Theological Seminaries founded by and bearing the name of the Crozer family. On the

principle that still waters run deep, he was deeply religious; I can not recall more than a few remarks made by him on theology, but they were enough to show that he had an attractive system. It may be said that he lived it rather than talked about it.

A very remarkable feature of the practice of medicine is the opportunity it offers for the formation of lasting friendships, both between doctors themselves and between doctors and their patients. This is so to such an extent as to make it seem unlikely that other callings are anywhere near it in this respect. I am sure that I speak not only for myself but for many of us who have been associated with him that Dr. Griffith's friendship was a treasure worth having. He did not pay us compliments so much by word of mouth as by many kindly acts. I have already spoken of his calling on me for help in the care of some member of his family, which is one of the highest compliments—I should say, the highest compliment one doctor can pay to another. Once, however, he made a complimentary remark to me which I did not appreciate at first; the occasion of it was the first time he called me in consultation in his private practice; as we were arranging the appointment I remarked that some time earlier I had been thinking of him and wondering, if just such a situation should arise in which he might desire a consultation for the psychological effect (I felt sure he would not need help from the medical side), who there would be here who could be helpful to him. He replied, "I selected you because I thought you would do less harm than any of the other young men." It was some time before I saw the compliment in it, but my first reaction was to its implications, for it gave me a most helpful thought, for which I should have thanked him, which I tried to bear in mind then and in all my subsequent consultation-work; and I am glad, in drawing the closing lines of this imperfect portrait, to pass the thought on to all the Fellows as a memento of Dr. Griffith, that our first aim when called in consultation should be to weigh every suggestion we are about to make with the question, "Has this any possibility of doing harm?"

The memory of Dr. Griffith will then be of help to us all.

Transactions of the Sections

SECTION ON GENERAL MEDICINE

Regular Meeting, January 26, 1942

The Sulfonamides in the Treatment of Bacterial Meningitis; Clinical and Pathological Considerations. (*Abstract 1, below.*) Matthew T. Moore*, M.D. (Commentator: John S. Lockwood, M.D.)

The Clinical Use of Graphic Registration of Heart Sounds. (*Abstract 2, below.*) Louis B. Laplace, M.D. (Commentator: Charles C. Wolferth, M.D.)

Primary Carcinoma of the Liver in Hemochromatosis. (*Abstract 3, below.*) J. Edward Berk*, M.D., and Marshall M. Lieber*, M.D. (Commentator: Abraham Cantarow, M.D.)

Observations on the Gastric Emptying Time. W. Osler Abbott, M.D. (Commentator: Harry Shay*, M.D.)

Regular Meeting, February 23, 1942

A Study of the Physiological Basis for Certain Symptoms of Hypertension, with Therapeutic Indications. (*Abstract 4, below.*) J. Q. Griffith, jr, M.D., and M. A. Lindauer, M.D. (Commentator: Louis B. Laplace, M.D.)

A Study of 1420 Medical Deaths (1930–1938 Inclusive). (*Abstract 5, below.*) Maurice S. Jacobs, M.D., and Louis Zisserman*, M.D. (Commentator: Charles L. Brown, M.D.)

The Use of Concentrated Blood Plasma in Certain Phases of Shock. (*Abstract 6, below.*) F. L. Munro*, M.D., L. A. Erf*, M.D., L. M. Tocantins, M.D., and H. W. Jones, M.D. (Commentator: Aims C. McGuinness, M.D.)

The Excretion of Bromsulfalein in the Bile. (*Abstract 7, below.*) C. W. Wirts, M.D., and A. Cantarow, M.D. (Commentator: Henry J. Tumen, M.D.)

SECTION ON MEDICAL HISTORY

Meeting, February 9, 1942[1]

Evolution in the Application of Medical Science. Esmond R. Long, M.D.

* *By invitation.*

[1] Joint meeting with the Philadelphia History of Science Society.

SECTION ON OPHTHALMOLOGY[2]

Regular Meeting, January 15, 1942

Clinical Study of the Blood Supply to the Optic Nerve and Chiasm. Derrick T. Vail, jr.,* M.D.

Regular Meeting, February 19, 1942

Further Studies on the Penetration of Sulfathiazole into the Eye. Harold G. Scheie*, M.D., and Irving S. Leopold*, M.D. (Commentator: Francis H. Adler, M.D.)

Temporary Abducens Paralysis Not Associated with Other General or Neurologic Abnormalities. Walter I. Lillie, M.D. (Commentator: Glen G. Gibson, M.D.)

Correction of Cicatricial Lagophthalmus; Motion Picture Demonstration. Edmund B. Spaeth, M.D.

SECTION ON OTOLARYNGOLOGY[3]

Regular Meeting, January 21, 1942

The Value of Roentgenology in the Diagnosis and Treatment of Some Otolaryngologic Conditions. Eugene P. Pendergrass, M.D., and W. E. Chamberlain, M.D. (Commentator: Karl M. Houser, M.D.)

Regular Meeting, February 18, 1942

Paralysis of the Larynx. Louis H. Clerf, M.D.

The Criteria for Selection of Treatment of Laryngeal Cancer. Chevalier L. Jackson, M.D., and John V. Blady*, M.D.

Benign Tumors of the Larynx, Inflammation and Neoplasm. Gabriel Tucker, M.D.

The Larynx, Tracheal Bronchial Tree and the Esophagus in Kodachrome. Paul H. Holinger*, M.D.

[2] The transactions of this Section are customarily abstracted in the *American Journal of Ophthalmology* and the *Archives of Ophthalmology*.

[3] The transactions of this Section are customarily abstracted in the *Archives of Otolaryngology*.

SECTION ON PUBLIC HEALTH, PREVENTIVE AND INDUSTRIAL MEDICINE

Meeting, February 2, 1942

Recent Advances in Industrial Medicine

Some Biological Factors Which Influence the Healing of Wounds. I. S. Ravdin, M.D. (Commentators: Sherman A. Eger*, M.D., and William B. Frazier*, M.D.)

A Case of Industrial Cadmium Poisoning with Predominant Neurologic Symptoms. P. Ralph Meloro*, M.D. (Commentators: Helena Riggs, M.D., John G. Reinhold*, PH.D., and Samuel B. Hadden, M.D.)

Abstracts

1. The Sulfonamides in the Treatment of Bacterial Meningitis; Clinical and Pathological Considerations. Matthew T. Moore, M.D.

Six cases of streptococcic and pneumococcic meningitis are presented, occurring in patients from 15 months to 48 years of age.

The neuropathologic studies indicate that adequate sulfonamide therapy can clear the subarachnoid space of inflammatory elements, and that inadequate therapy plus existing foci of infection permit a chronic exudative and proliferative process to develop stimulating tuberculous meningitis.

The cases reported present a number of significant problems concerning the sulfonamide treatment of forms of meningitis hitherto regarded as having a hopeless prognosis, problems having to do with dosage, toxicity, use of anti-sera, prophylaxis in paranasal sinus infection, middle ear disease and mastoid disease, surgical and non-surgical attention to foci of infection, and the possible occurrence of sequelae in protracted cases of meningitis which finally recover.

On the basis of the material presented, suggestions are offered in the way of prophylactic and active treatment, emphasizing that in the virulent meningitides, it is safer to give too much sulfonamide too soon than too little too late.

2. Clinical Use of Graphic Registration of Heart Sounds. Louis B. Laplace, M.D.

Recent improvement in the apparatus for graphic registration of heart sounds has made this procedure available for clinical use. The records obtained are still subject to the criticism that they may involve certain technical inaccuracies. Artefacts are also a common source of error. With certain specified limitations, recording of the heart sounds may prove useful in the diagnosis of cases in which the clinical evidence is ambiguous. At present, however, the most valuable aspect of the procedure is the training which it affords the physician in the correct interpretation of what he hears with the stethoscope.

3. Primary Carcinoma of the Liver in Hemochromatosis. J. Edward Berk, M.D., and Marshall M. Lieber, M.D.

Primary carcinoma of the liver occurs with surprising frequency in hemochromatosis (7.3%). The incidence appears to be greater than in uncomplicated hepatic cirrhosis (4.5%) and is apparently due to other factors in addition to the cirrhosis of the liver found in hemochromatosis.

The coexistence of a primary carcinoma of the liver in a known or suspected case of hemochromatosis is suggested whenever any or all of the following occur: a symptom complex of short duration and rapid progression; abdominal pain; jaundice; a rapidly recurring, sanguineous ascites; a markedly enlarged liver which extends upward and is extremely hard and grossly nodular; sudden amelioration of the diabetes and/or liability to hypoglycemic intervals; fever; anemia; leukocytosis; weight loss; evidence of metastatic involvement, especially of the lung.

Early diagnosis and prompt attempt at surgical removal of the neoplastic process is the only procedure of any avail.

4. A Study of the Physiological Basis for Certain Symptoms of Hypertension, with Therapeutic Indications. J. Q. Griffith, jr, M.D., and M. A. Lindauer, M.D.

One hundred and thirty-eight subjects with hypertension have been analyzed in three ways: (1) as to the presence of symptoms of vertigo, headache, tinnitus, cardiac pain, dyspnea, weakness, fainting spells, paraesthesias, edema and apoplexy; (2) as to the presence or absence of a substance in the blood capable of inhibiting water diuresis in rats. (3) as to the presence of a normal or increased cutaneous lymphatic flow, in 74 of the total group.

No significant correlation between symptoms and antidiuretic substance or rate of cutaneous lymphatic flow was demonstrated, but it was noted

* *By invitation.*

that there was a tendency for headaches to occur in a very high proportion of persons with increased cutaneous lymphatic flow and that vertigo, cardiac pain, and perhaps tinnitus were more common in subjects with normal cutaneous lymphatic flow and negative antidiuretic test. It was concluded that symptoms could not replace these tests in selecting persons suitable for either thiocyanate medication or pituitary irradiation as a treatment for hypertension.

5. A Study of 1420 Medical Deaths (1930–1938 Inclusive). Maurice S. Jacobs, M.D., and Louis Zisserman, M.D.

Our study represented an analysis of all medical deaths of 1930–1938 inclusive at the Jewish Hospital. The six principal causes of death in this series were, in the order of frequency: (1) the diseases of the heart; (2) pneumonia (all forms); (3) malignancies; (4) cerebral accidents, excluding trauma; (5) nephritis; (6) tuberculosis. The six disease-groups accounted for over eighty per cent of all the deaths.

Of the diseases of the heart, which accounted for over thirty per cent of all the deaths, myocardial disease and acute coronary thrombosis were the most important. In the latter disease it was interesting to find that our statistics showed an incidence of males and females of two to one.

Because of the fact that almost half of the cases (forty-seven per cent) came to autopsy, it was possible to present a survey of diagnostic accuracy. This revealed that diseases, e.g., myocardial degeneration, are diagnosed too frequently in the clinical cases, whereas malignancy is not diagnosed often enough. Diseases such as acute coronary occlusion and subacute bacterial endocarditis, which can be diagnosticated with greater exactness, were found to be so diagnosed in the clinical and autopsied cases alike.

The commonest secondary diagnoses made were bronchopneumonia (10%), nephrosclerosis (9.8%), diabetes mellitus (6.9%), valvular heart disease (6.9%), cholelithiasis (proved at autopsy, 11%), chronic glomerulo nephritis (4%).

Finally, an interesting comparison was made between the incidence of certain diseases among Israelites and non-Israelites. An analysis of our case material revealed that the ratio of Israelites to non-Israelites was 1.8 to 1. With this information as a base, we analyzed a number of cases of varied diseases, such as myocardial disease, cerebral accident, malignancy, which occurred in the non-Israelites and multipled by the factor 1.8 to see the number of cases which should have been present among the Israelites. From this analysis it was evident that myocardial disease appeared over twice as frequently among the Israelites as the expectancy, cerebral accidents about 10% more frequently, malignancy almost in the expected amount, acute coronary occlusion one and one-half times as frequently, lobar pneumonia one-third as frequently and pulmonary tuberculosis and subacute bacterial endocarditis in the expected amount.

6. The Use of Concentrated Plasma in Certain Phases of Shock. F. L. Munro, M.D., L. A. Erf, M.D., L. M. Tocantins, M.D., H. W. Jones, M.D.

Opinion differs concerning the use of the various forms of plasma in shock and in other conditions. There is a difference of opinion as to the etiology of shock. Everyone is agreed, however, that in shock we have a reduced amount of blood for return to the heart, increased capillary bed, anoxemia and capillary hyperpermeability. The earlier shock is treated, the more quickly adequate material is administered, the better the results.

In civilian emergencies and in military shock, plasma should be immediately available, should be able to be given at once with a minimum of equipment; the dried plasma should be quickly soluble.

The concentrated plasma made at Jefferson fulfills these requirements. It is small in bulk, it dissolves in within 30–60 seconds, is administered with a syringe, contains all components, quickly increases blood pressure, produces hemodilution and, in a sufficient dose, reverses the mechanism of shock. This concentrated plasma has its *p*H reduced to normal by the addition of CO_2. From the time the patient is seen to the completion of the injection, as little as 3 minutes may elapse.

It can be given intrasternally with as great ease as intravenously. The intrasternal method is of particular value on the field, in mobile units or on deck during battle before the casualty can be moved to more stable bases for treatment requiring more complicated apparatus. The intrasternal method is not advocated if veins are easily available.

7. Excretion of Bromsulfalein in the Bile. C. W. Wirts, M.D. and A. Cantarow, M.D.

A study of the excretion of bromsulfalein in the bile following intravenous injection has been

carried out in patients by means of duodenal biliary drainage, or by T-tube in the common duct, and in permanent biliary-fistula dogs. The fractional concentration as well as the total dye excreted in two hours was estimated and correlated with the rate of removal from the blood.

Under normal conditions, after injecting 2 mgs. of dye per kilogram of body weight, the dye appears in the bile within fifteen minutes and reaches a maximum concentration (50–532 mgs. per cent) in forty-five to sixty minutes, subsequently falling to a relatively low level at two hours, and often not disappearing completely for five to six hours. Normally thirty-five to eighty-three per cent of the quantity was excreted in the first hour and sixty-one to one hundred per cent in the first two hours. Abnormal excretion of the dye is evidenced by one or more of the following phenomena: (1) delayed removal from the blood; (2) delayed entrance into the bile; (3) delayed attainment of the maximum concentration in the bile; (4) prolonged high curve of excretion in the bile; (5) subnormal concentration in the bile and (6) abnormally low excretion within one or two hour periods after injection.

Comment: Since eighty-five to ninety-five per cent of the dye leaves the blood within five minutes and all is removed in thirty minutes, two phases of the excretion of bromsulfalein from the body must be recognised: (1) its rapid removal from the blood by, and possibly its storage in, the Kupffer and, possibly, other reticulo-endothelial cells; (2) gradual passage of the dye into the hepatic polygonal cells, and its excretion in the bile. A third possibility is that temporary storage of the dye occurs in the hepatic, rather than the reticulo-endothelial cells.

The rate of removal of the dye from the blood, utilized in the study of liver function, represents but one phase of its excretion by that organ, and may be normal in the presence of distinct abnormalities in the second, or biliary, phase of its excretion.

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1912. Addison, William H. F., Medical Laboratories, Univ. of Pa.
1926. Adler, Francis Heed, 313 S. 17th St.
1914. Aiken, Thomas G., Berwyn, Pa.
1936. Aldridge, Fred Cutler, Wayne, Pa.
1936. Alexander, Fay Knight, 8835 Germantown Ave.
1906. Allen, Francis Olcott, Jr., 2216 Walnut St.
1932. Allen, Frederick H., 1711 Fitzwater St.
1935. Alpers, Bernard J., 111 North 49th St.
1933. Alston, Robert S., 121 Walnut Lane.
1905. Anspach, Brooke M., 1827 Spruce St.
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1905. Appleman, Leighton Francis, 308 S. 16th St.
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1922. Arnett, John H., 2116 Pine St.
1942. Aronson, Joseph D., 416 Oak Lane, Wayne, Pa.
1941. Aronson, Roland S., Medical Corps, U. S. Army, Apt. 171, 1201 So. Barton St., Arlington, Va.
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1935. Atlee, John L., 37 E. Orange St., Lancaster, Pa.
1935. Atlee, John L., Jr., 37 E. Orange St., Lancaster, Pa.
1914. Austin, J. Harold, 821 Maloney Clinic, Univ. of Pa.
1906. Babbitt, James A., 1912 Spruce Street.
1935. Bach, Theodore F., 1900 Rittenhouse Sq.
1942. Bachman, Carl, Univ. of Pa. Hospital.
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1908. Beardsley, E. J. G., 1919 Spruce St.
1930. Beardwood, Joseph T., Jr., 2031 Locust St.
1935. Beerman, Herman, Chatham Court Apts., 49th and Locust Sts.
1932. Behney, Charles A., 3722 Chestnut St.

1942. Behrend, Albert, 1738 Pine St.
1934. Behrend, Moses, 1738 Pine St.
1930. Belk, William Parks, Ardmore, Pa.
1936. Bell, Benjamin Tertius, 1930 Chestnut St.
1941. Bernstein, Mitchell, 1321 Spruce St.
1937. Bertolet, J. Allan, 1530 Locust St.
1934. Biddle, Sydney Geoffrey, 255 S. 17th St.
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1923. Bond, Earl D., 707 Old Lancaster Road, Bryn Mawr, Pa.
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1924. Boon, David J., 1532 N. 15th St.
1931. Bortz, Edward Le Roy, 2021 W. Girard Ave.
1921. Borzell, Francis Frank, 4940 Penn St., Frankford.
1936. Bostwick, Delazon Swift, 106 Linwood Ave., Ardmore, Pa.
1928. Bothe, Albert E., 255 S. 17 St.
1928. Bothe, Frederick A., 255 S. 17 St.
1942. Bowie, Morris A., 910 Old Lancaster Road, Bryn Mawr, Pa.
1923. Bower, John O., 2008 Walnut St.
1907. Boyer, Henry P., 4602 Baltimore Ave.
1925. Boykin, Irvine M., 136 S. 16th St.
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1907. Bradley, William Nathaniel, 1725 Pine St.
1942. Branen, William, Whitby & Cypress Ave., Yeadon, Pa.
1921. Bransfield, John W., 2101 Spruce St.
1903. Branson, Thomas F., Rosemont, Pa.
1917. Bromer, Ralph S., 629 Pembroke Road, Bryn Mawr, Pa.
1936. Brown, Charles L., 325 N. Bowman Ave., Merion, Pa.
1932. Brown, Claude P., 1930 Chestnut St.
1919. Brown, Henry P., Jr., 1930 Chestnut St.
1887. Brubaker, Albert P., 109 N. 34th St.
1939. Brust, Raymond W., 4710 Chester Ave.
1935. Buchanan, Mary, 1737 Chestnut St.
1930. Bucher, Carl Joseph, 271 S. 15th St.
1928. Burden, Verne G., 255 S. 17th St.
1940. Burnett, W. Emory, 3401 N. Broad St.
1906. Burns, Stillwell C., 1238 Atwood Rd.
1892. Burr, Charles W., 1527 Pine St.
1941. Butler, Miriam, 1831 Chestnut St.
1906. Butler, Ralph, 1930 Chestnut St.
1934. Buzby, B. Franklin, 414 Cooper St., Camden, N. J.
1907. Cadwalader, Williams B., 133 S. 36th St.
1928. Campbell, Edward H., 2035 Delancey St.
1931. Cantarow, Abraham, 2033 Delancey St.
1935. Carey, Lawrence S., 1930 Chestnut St.
1931. Cariss, Walter L., 2043 Walnut St.
1930. Carpenter, Chapin, 1930 Chestnut St.
1905. Carpenter, Herbert B., 1805 Spruce St.

1926. Carpenter, Howard Childs, 1805 Spruce St.
1895. Carpenter, John T., 1930 Chestnut St.
1917. Carson, John B., 1802 Pine St.
1922. Case, Eugene A., 63 W. La Crosse Ave., Lansdowne, Pa.
1937. Castallo, Mario A., 2126 Spruce St.
1933. Chamberlain, W. Edward, Temple University Hospital.
1939. Chamberlin, George W., Reading Hospital, Reading, Pa.
1900. Chance, Burton, 317 S. 15th St.
1939. Charr, Robert Kyun Hyun, 738 Pine St.
1941. Cheleden, John, 269 S. 19th St.
1903. Chrystie, Walter, Bryn Mawr, Pa.
1939. Ciccone, Emmet F., 312 N. 33rd St.
1929. Clark, Eliot R., 315 S. 41st St.
1934. Clark, Jefferson Hamer, 3701 N. Broad St.
1926. Clarke, J. Alexander, 334 S. 21st St.
1926. Clerf, Louis H., 1530 Locust St.
1910. Cloud, J. Howard, 11 W. Montgomery Ave., Ardmore, Pa.
1903. Coates, George Morrison, 1721 Pine St.
1908. Codman, Charles A. E., S.E. Corner 42d and Spruce Sts.
1941. Cohen, J. Gershon, 255 S. 17th St.
1922. Cohen, Leon Solis-, 1923 Spruce St.
1907. Cohen, Myer Solis-, 2110 Spruce St.
1888. Cohen, S. Solis-, 1906 Walnut St.
1920. Cole, Charles J., 7926 Park Ave., Elkins Park, Pa.
1934. Colgan, Robert C., 5734 N. 5th St.
1934. Collins, Leon Howard, Jr., 133 S. 36th St.
1939. Comroe, Bernard I., 1726 Pine St.
1930. Cooper, David A., 1520 Spruce St.
1941. Cornelius, Chalmers E., 119 Summit Ave., Jenkintown, Pa.
1911. Cornell, Walter S., Board of Public Education, Parkway and 21st St.
1914. Corson, Edward F., 136 S. 16th St.
1930. Cottrell, James E., 2031 Locust St.
1924. Cowan, Alfred, 1930 Chestnut St.
1940. Cowan, Thomas H., 1930 Chestnut St.
1904. Craig, Frank A., The Henry Phipps Institute, 7th and Lombard Sts.
1942. Craighill, Margaret D., Woman's Medical College.
1907. Crampton, George S., 2031 Locust St.
1937. Crane, Martin P., 2433 Germantown Ave.
1920. Creighton, William J., 37 S. 20th St.
1941. Creskoff, Adolph J., 3400 Spruce St.
1920. Cross, George H., Chester, Pa.
1917. Cross, Sumner H., P. O. Box 126, Jenkintown, Pa.
1921. Crossan, Edward T., 5324 Wayne Ave.
1940. Crowe, Aldrich C., 735 Atlantic Ave., Ocean City, N. J.
1904. Cruice, John M., 407 S. 22d St.
1937. Crump, Jean, 1930 Chestnut St.
1937. Curtis, Lawrence, 255 S. 17th St.
1934. Custer, R. Philip, Orchard Lane, Haverford, Pa.
1941. Cuttle, Tracy D., 255 S. 17th St.
1938. Dannenberg, Arthur M., 235 S. 15th St.
1919. Davies, John R., Jr., 2 E. Chestnut Ave., Chestnut Hill.
1936. Davis, David M., 225 S. 17th St.

1937. Davis, Perk Lee, 255 S. 17th St.
1916. Davis, Warren Beagle, 135 S. 18th St.
1900. Davisson, Alexander H., 900 N. Broad St.
1935. Deaver, J. Montgomery, 1830 Delancey Pl.
1902. Dehoney, Howard, 240 S. 13th St.
1935. Deibert, Irvin Elmer, 538 Cooper St., Camden, N. J.
1924. Deichler, L. Waller, 1930 Chestnut St.
1923. De Long, Perce, N.E. Cor. 20th and Chestnut Sts.
1928. Dewees, A. Lovett, Times Medical Bldg., Ardmore, Pa.
1924. Dillon, Edward S., 2016 DeLancey St.
1932. Dintenfass, Henry, 1305 Spruce St.
1920. Diven, John, 326 S. 19th St.
1941. Dixon, Harold M., 4107 Chester Ave.
1920. Doane, Joseph C., 19th and Spruce Sts.
1942. Donnelly, Edward J., 1721 W. Girard Ave.
1933. Donnelly, Joseph C., 2008 Walnut St.
1937. Donnelly, Robert T. M., 255 S. 17th St.
1907. Dorrance, George M., 2101 Spruce St.
1933. Downs, T. McKean, Mt. Pleasant Road, Bryn Mawr, Pa.
1910. Drayton, William, Jr., 2028 Delancey St.
1935. Duane, William, Jr., 2031 Locust St.
1935. Duncan, Garfield G., 1930 Chestnut St.
1937. Dunn, Charles W., 269 S. 19th St.
1942. Durant, Thomas M., Broad and Ontario Sts.
1935. Eads, John T., 2029 Delancey St.
1911. Earnshaw, Henry C., Bryn Mawr, Pa.
1936. Easby, Mary Hoskins, 1930 Chestnut St.
1937. Edeiken, Joseph, 1832 Spruce St.
1930. Eiman, John, Cynwyd, Pa.
1911. Eliason, Eldridge L., 326 S. 19th St.
1939. Ellis, Van Mashburn, 1530 Locust St.
1928. Ellison, Richard T., 1614 Locust St.
1936. Ellson, J. Vernon, 255 S. 17th St.
1904. Elmer, Walter G., 1801 Pine St.
1937. Elsom, Kendall A., 133 S. 36th St.
1934. Ely, William C., 3912 Chestnut St.
1932. Engel, Gilson G., 1914 Pine St.
1942. Erb, William H., 4 Morton Ave., Ridley Park, Pa.
1893. Eshner, Augustus A., 1019 Spruce St.
1905. Evans, William, 500 W. Gay St., West Chester, Pa.
1912. Eves, Curtis C., 1910 Spruce St.
1922. Farley, David L., 4429 Larchwood Ave.
1903. Farr, Clifford B., Bryn Mawr, Pa.
1930. Farrell, John T., Jr., 255 S. 17th St.
1935. Ferguson, Lewis Kraeer, 133 S. 36th St.
1936. Fetter, Ferdinand, 322 S. 21st St.
1935. Fetter, Theodore R., 255 S. 17th St.
1924. Fewell, Alexander G., 1924 Pine St.
1928. Fitz-Hugh, Thomas, Jr., 2016 Delancey St.
1928. Flick, John B., Mermont Plaza, Bryn Mawr, Pa.
1939. Flippin, Harrison F., 255 S. 17th St.
1940. Forrester, James S., 714 Maloney Clinic, Univ. of Pa.

1941. Fox, C. Calvin, 1806 Spruce St.
1906. Fraley, Frederick, 71st and City Line, Overbrook, Pa.
1941. Frazier, William Doane, 133 S. 36th St.
1939. Freeman, Norman E., 320 Hathaway Lane, Wynnewood, Pa.
1935. Fridy, Cyrus Ward, 322 Riverview Ave., Drexel Hill, Pa.
1933. Fritch, James Scott, 269 S. 19th St.
1937. Fritz, Herbert H., Penswood Rd. and Radnor St., Bryn Mawr, Pa.
1940. Fry, Kenneth E., 1611 Spruce St.
1935. Fry, Wilfred Eyles, 1819 Chestnut St.
1937. Furlong, Thomas F., Jr., Times Medical Building, Ardmore, Pa.
1899. Gamble, Robert G., Haverford, Pa.
1935. Gammon, Geo. D., Univ. of Pa. Hospital.
1931. Garner, Vaughn C., Germantown Professional Building.
1935. Geist, Donald C., 1930 Chestnut St.
1917. Gerhard, Arthur H., 1615 N. Delaware Ave.
1899. Gibbon, John H., Media, Pa.
1934. Gibbon, John H., Jr., 4035 Pine St.
1939. Gibson, Glen Gregory, 255 S. 17th St.
1933. Gifford, U. Grant, Kennett Square, Pa.
1920. Gill, A. Bruce, 1930 Chestnut St.
1931. Gilman, Robert Louis, 1930 Chestnut St.
1927. Gilmour, William R., 6616 Woodland Ave.
1931. Giordano, Anthony A. S., 1819 S. Broad St.
1920. Githens, Thomas S., The Cambridge, Wissahickon and School Lane.
1906. Gittings, John C., Harwood, Md.
1906. Goepp, R. Max, 1333 Chestnut St.
1933. Goldburgh, Harold L., 1932 Spruce St.
1935. Goldsmith, Ralph, 136 S. 16 St.
1905. Gordon, Alfred, 1900 Locust St.
1928. Gordon, Burgess L., 1832 Spruce St.
1937. Gordon, William, 1721 Pine St.
1941. Gouterman, Joseph I., 334 W. School Lane, Germantown.
1894. Graham, Edwin E., 1713 Spruce St.
1926. Grant, Francis Clark, Univ. of Pa. Hospital.
1933. Greenbaum, Sigmund S., 320 S. 18th St.
1940. Greene, Lloyd B., 136 S. 16 St.
1932. Griffith, George C., 4028 Walnut St.
1934. Griffith, John Q., Jr., 214 Glencoe Ave., Upper Darby, Pa.
1912. Griscom, J. Milton, 255 S. 17th St.
1941. Groff, Robert A., 255 S. 17th St.
1933. Gruber, Charles M., Jefferson Medical College.
1932. Guequierre, Jacques P., 1930 Chestnut St.
1935. Hadden, Samuel B., 37 S. 20th St.
1935. Haines, Harlan F., 134 S. State Rd., Upper Darby, Pa.
1939. Hamblock, Leonard C., 2230 S. Broad St.
1894. Hamill, S. McC., 1822 Spruce St.
1897. Hand, Alfred, 1724 Pine St.
1938. Hand, John G., 1724 Pine St.
1932. Harris, Stanley E., Lansdowne, Pa.
1929. Harrison, Francis G., 1900 Spruce St.
1933. Harrison, William John, 135 S. 17th St.
1903. Hart, Charles D., 420 W. Mermaid Lane, Chestnut Hill.

1941. Hartley, Harriet L., 1719 Rittenhouse Square.
1932. Hartman, J. Calvin, 100 W. Walnut Lane.
1926. Hartmann, Fred L., 1914 Pine St.
1935. Haskell, Benjamin F., 1426 Spruce St.
1936. Hatch, Lerleen Clement, Univ. of Pa. Hospital.
1907. Hatfield, Charles James, Henry Phipps Institute, 7th and Lombard Sts.
1911. Heed, Charles R., 1205 Spruce St.
1927. Herman, Leon, 136 S. 16 St.
1924. Hewson, William, 6013 Greene St.
1924. Hirst, John C., 2d, 500 N. 20th St.
1908. Hitchens, Arthur Parker, Medical School, Univ. of Pa.
1939. Hodes, Philip J., X-Ray Dept., Univ. of Pa. Hospital.
1905. Hodge, Edward B., 2019 Spruce St.
1931. Holland, H. Albert, 8200 Crittenden St., Chestnut Hill.
1933. Hollingshead, Irving W., 123 S. 18th St.
1932. Hollingsworth, I. Pemberton P., 411 N. Walnut St., West Chester, Pa.
1919. Hopkins, Arthur H., 1726 Pine St.
1925. Hopkinson, R. Dale, Jenkintown, Pa.
1928. Houser, Karl Musser, 2010 Spruce St.
1938. Howell, John Carnett, 326 S. 19th St.
1937. Hughes, Joseph, 4401 Market St.
1939. Hughes, P. Boland, Alden Park Manor, Germantown.
1892. Hughes, William E., 3945 Chestnut St.
1937. Hughson, Walter, Abington Memorial Hospital, Abington, Pa.
1923. Hume, John E., N.E. Corner 20th and Chestnut Sts.
1921. Hunter, Robert John, 2011 Chestnut St.
1926. Husik, David N., 1820 Spruce St.
1934. Hustead, Frank H., 5112 N. Broad St.
1898. Hutchinson, J. P., Media, Pa.
1935. Ingleby, Helen, Woman's Medical College, Phila.
1921. Ivy, Robert H., 1930 Chestnut St.
1917. Jackson, Chevalier, 255 S. 17th St.
1932. Jackson, Chevalier L., 255 S. 17th St.
1934. Jacobs, Maurice S., 1831 De Lancey Place.
1922. Jameson, Howard Leon, 250 S. 17th St.
1941. Jeffers, William A., 133 S. 36th St.
1913. Jeffreys, William H., 143 Gray's Lane, Haverford, Pa.
1928. John, Rutherford L., 256 S. 21st St.
1926. Johnson, George Ernest, 5341 Chester Ave.
1942. Johnson, Julian, 406 Conshohocken State Road, Penn Valley, Pa.
1938. Johnson, Thomas A., 250 S. 18th St.
1918. Jonas, Leon, 255 S. 17th St.
1924. Jones, Harold W., 1930 Chestnut St.
1900. Judson, Charles F., 252 Kent Road, Wynnewood, Pa.
1902. Jump, Henry Draper, 2019 Walnut St.
1936. Kain, Thomas M., 403 Cooper St., Camden, N. J.
1938. Kasper, Kelvin A., 135 S. 18th St.
1941. Kauffman, M. Luther, Medical Arts Bldg., Jenkintown, Pa.
1926. Kaufman, Isadore, 2054 Locust St.
1923. Kay, James, 600 W. Olney Ave.
1938. Keeler, Harold R., 1824 Spruce St.
1913. Kelly, Francis J., 260 S. 21st St.

1935. Kelly, George F. J., N.E. Cor. 20th and Chestnut Sts.
1932. Kelly, Herbert T., 1900 Spruce St.
1909. Kelly, James A., 1815 Spruce St.
1912. Kelly, Thomas C., 105 School Lane.
1941. Kennedy, Patrick J., 65 Fairview Ave., Lansdowne, Pa.
1921. Kern, Richard A., Univ. of Pa. Hospital.
1935. Keyes, Baldwin L., 2025 Walnut St.
1930. Kimbrough, Robert A., Jr., 807 Spruce St., Phila.
1936. King, Orville C., 255 S. 17th St.
1931. Kinney, Willard H., 315 S. 17th St.
1920. Klauder, Joseph V., 1934 Spruce St.
1920. Klein, Thomas, 250 S. 18th St.
1934. Klemmer, Roland N., 439 North Duke St., Lancaster, Pa.
1934. Kline, Oram R., 414 Cooper St., Camden, N. J.
1932. Klopp, John W., 618 W. Lehigh Ave.
1919. Knipe, Norman L., 1930 Chestnut St.
1908. Knowles, Frank C., 2035 Spruce St.
1938. Knox, Andrew, 1930 Chestnut St.
1925. Knox, Harry E., 719 66th Ave., Oak Lane.
1914. Kolmer, John A., Cynwyd, Pa.
1936. Konzelmann, Frank Williamson, 3638 N. 21st St.
1932. Kornblum, Karl, 1020 Sansom St.
1941. Krall, J. Thomas, 1927 Spruce St.
1904. Krauss, Frederick, 1930 Chestnut St., Phila.
1941. Krewson, William E., 3rd, 1930 Chestnut St.
1914. Krumbhaar, Edward B., School of Medicine, Univ. of Pa.
1900. Krusen, Wilmer, Phila. College of Pharmacy.
1907. Langdon, H. Maxwell, 1530 Locust St.
1933. Langdon, Roy L., 5917 Greene St., Germantown.
1941. Langner, Paul H., Jr., 130 S. 18th St.
1934. Laplace, Louis B., 1900 Rittenhouse Sq.
1926. Laws, George M., 1907 Spruce St.
1936. Leaman, William G., 3700 Baring St.
1920. Leavitt, Frederic Headley, 1527 Pine St.
1941. Leberman, Paul R., 136 S. 16 St.
1934. Lee, Thomas B., 622 Cooper St., Camden, N. J.
1908. Lee, Walter Estell, 1833 Pine St.
1942. Lehman, James A., 1815 Spruce St.
1936. Lehrfeld, Louis, 1321 Spruce St.
1935. Lemmon, William T., 1930 Chestnut St.
1920. Leopold, Simon S., 2025 Spruce St.
1933. Levering, J. Walter, 1309 Oak Lane.
1915. Lewis, Fielding O., Providence Road, Media, Pa.
1938. Lewis, James P., 3815 Chestnut St.
1936. Lillie, Walter I., 255 S. 17th St.
1940. Limberger, William A., 301 S. Church St., West Chester, Pa.
1938. Lindauer, M. August, 1406 S. 58 St.
1927. Lindsey, Walter H., 810 W. Dauphin St.
1936. Lintgen, Charles, 1930 Chestnut St.
1936. Llewellyn, Thomas H., 739 N. 40th St.
1941. Lockwood, John S., 301 Hathaway Lane, Wynnewood, Pa.
1907. Lodholz, Edward, Medical Laboratories, Univ. of Pa.

1931. Loewenberg, Samuel A., 1905 Spruce St.
1938. Long, Charles-Francis, 1836 Delancey St.
1933. Long, Esmond R., Henry Phipps Institute, 7th and Lombard Sts.
1935. Long, William L., 2025 Walnut St.
1893. Longaker, Daniel, 5702 Overbrook Ave.
1931. Longaker, Edwin P., 41 E. Montgomery Ave., Ardmore, Pa.
1936. Lucchesi, Pascal Francis, Philadelphia Hospital for Contagious Diseases.
1921. Lucké, Balduin H. E., Medical School, Univ. of Pa.
1924. Ludy, John B., 136 S. 16th St.
1932. Lukens, Francis D. W., Cynwyd, Pa.
1938. Lukens, Philip Jefferson, Jr., 158 E. Butler Ave., Ambler, Pa.
1930. Lukens, Robert M., 1923 Spruce St.
1929. Lull, Clifford B., Women's Bldg., Penna. Hosp., 807 Spruce St.
1939. Luongo, Romeo A., 2054 Locust St.
1919. Lynch, Frank B., Jr., The Germantown Hospital, E. Wister St., Germantown.
1914. Lyon, B. B. Vincent, 1930 Chestnut St.
1933. McAndrews, Leo F., Mermont Plaza, Bryn Mawr, Pa.
1932. McCahey, James F., 1534 Pine St.
1900. McCarthy, Daniel J., 2025 Walnut St.
1936. McCarthy, Patrick A., Central Medical Bldg.
1935. McClenahan, William U., 3 Summit Ave., Chestnut Hill.
1931. McCloskey, Edward, 7 E. Chestnut Ave., Chestnut Hill.
1935. McConnell, James W., 20th and Chestnut Sts.
1934. McCouch, Grayson P., Medical School, Univ. of Pa.
1938. McCrea, Lowrain E., 1930 Chestnut St.
1937. McCutcheon, Morton, Alden Park Manor, Germantown.
1942. McDonald, P. Robb, 6608 Wayne Ave., Germantown.
1895. McFarland, Joseph, 542 W. Hortter St., Germantown.
1937. McGuinness, Aims C., The Children's Hospital, 1740 Bainbridge St.
1940. McLaughlin, Edward F., 6605 Lincoln Drive.
1933. McLaughlin, James S., 334 S. 21st St.
1924. McMillan, Thomas M., 2044 Locust St.
1924. McPhedran, F. Maurice, Germantown Hosp., Penn and Chew Sts.
1932. Macfarlane, Catharine, 136 S. 16 St.
1910. Mackinney, William H., 1930 Chestnut St.
1936. MacMurtrie, Wm. J., 912 S. 49th St.
1939. Macneill, Norman M., 5116 N. 5th St.
1935. Maeder, LeRoy M. A., 206 S. 13th St.
1935. Maier, Ernest G., 1323 N. 15th St.
1914. Maier, F. Hurst, 2019 Walnut St.
1942. Manges, Lewis C., Jr., 3321 W. Penn St.
1936. Mann, Bernard, 2019 Pine St.
1937. Margolies, Alexander, 1836 Delancey St.
1941. Martin, James R., 136 S. 16 St.
1935. Mason, James B., 1530 Locust St.
1935. Matthews, Robert A., 111 N. 49th St.
1939. May, Hans, 5501 Greene St.
1932. Meade, Richard H., Jr., 2016 Pine St.
1934. Mecray, Paul M., 405 Cooper St., Camden, N. J.
1914. Mencke, J. Bernhard, 1816 Spruce St.
1941. Mendell, Theodore H., 1820 Spruce St.
1940. Mengel, Willard G., 400 Penn St., Camden, N. J.

1937. Meyer, George Phillip, 410 Haddon Ave., Camden, N. J.
1935. Miller, Ford A., 4016 Chestnut St.
1934. Miller, Hugh McCauley, 1614 Locust St.
1939. Miller, Malcolm W., 2021 W. Girard Ave.
1939. Miller, Merle M., 6013 Greene St.
1932. Miller, M. Valentine, 114 W. Phil-Ellena St.
1921. Miller, T. Grier, Univ. of Pa. Hospital.
1937. Missett, Joseph Vincent, Jr., 1814 Spruce St.
1904. Mitchell, Charles Franklin, 2003 Pine St.
1932. Mohler, Roy W., 1806 Spruce St.
1936. Montgomery, Hugh, 216 Kent Rd., Ardmore, Pa.
1936. Montgomery, John B., 1930 Chestnut St.
1932. Montgomery, Thaddeus L., 2031 Locust St.
1928. Moon, Virgil H., Jefferson Medical College.
1935. Moore, John Royal, Beury Bldg., Broad St. and Erie Ave.
1924. Moorhead, Stirling W., 1523 Pine St.
1936. Morgan, David R., Jefferson Medical College.
1886. Morris, Caspar, Haverford, Pa.
1893. Morris, Elliston J., 225 Upland Way, Wayne, Pa.
1941. Mucklé, Craig Wright, 3514 Williamsburg Lane, N.W., Washington, D. C.
1929. Mudd, Stuart, Department of Bacteriology, Medical School, Univ. of Pa.
1935. Mullen, Carroll Richard, 2025 Locust St.
1934. Mullen, Edward A., 2615 W. Somerset St.
1905. Muller, George P., 1930 Spruce St.
1930. Murphy, Douglas P., 3815 Chestnut St.
1934. Murphy, Eugene C., 1841 S. Broad St.
1905. Mutschler, Louis H., 1625 Spruce St.
1936. Nelson, Guy M., 928 Clinton St.
1905. Newcomet, William S., 3501 Baring St.
1938. Newton, Zachariah B., 7109 McCallum St., Mt. Airy.
1935. Nicholson, Jesse Thompson, 1614 Locust St.
1899. Nicholson, William Rufus, 2023 Spruce St.
1941. Nisbet, Verner, 254 S. 45th St.
1905. Norris, Charles C., 133 S. 36th St.
1938. Norris, Robert F., Pennsylvania Hospital, 8th and Spruce Sts.
1941. North, John Paul, 322 S. 21st St.
1933. Nylin, Josef B., Univ. of Pa. Hospital.
1941. Odenatt, Wm. Burrill, 1213 W. Lehigh Ave.
1913. O'Neal, Alexander Hay, St. Davids, Pa.
1936. Orr, Theodore E., 1930 Chestnut St.
1913. Outerbridge, George W., 1927 Spruce St.
1915. Owen, Hubley R., 319 S. 16th St.
1897. Packard, Francis R., 304 S. 19th St.
1933. Palmer, Harold Dean, 111 N. 49th St.
1909. Parish, Benjamin Dores, 1927 Spruce St.
1940. Parker, Alan P., 255 S. 17th St.
1931. Paul, John Davis, 3112 N. Broad St.
1932. Payne, Franklin L., Univ. of Pa. Hospital.
1922. Pelouze, P. S., 1737 Chestnut St.
1909. Pemberton, Ralph, Paoli, Pa.
1930. Pendergrass, Eugene P., Univ. of Pa. Hospital.
1932. Pennell, Howard Y., West Chester, Pa.

1939. Pepper, D. Sergeant, Walter Reed General Hospital, Washington, D. C.
1914. Pepper, O. H. Perry, Univ. of Pa. Hospital.
1902. Pepper, William, School of Medicine, Univ. of Pa.
1916. Percival, Milton Fraser, 2332 S. Broad St.
1942. Perkins, William Harvey, 1025 Walnut St.
1940. Pessel, Johannes F., Mahlon Drive, Yardley, Pa.
1917. Peter, Luther Crouse, 1930 Chestnut St.
1937. Pettit, Horace, 255 S. 17th St.
1905. Pfahler, George E., 1930 Chestnut St.
1915. Pfeiffer, Damon B., Meadowbrook, Pa.
1935. Phillips, Arthur W., 3904 Walnut St.
1911. Piersol, George Morris, 2031 Locust St.
1933. Pillsbury, Donald M., 133 S. 36th St.
1905. Pitfield, Robert L., 5211 Wayne Ave.
1922. Pleasants, Henry, Jr., West Chester, Pa.
1937. Polk, David Stewart, Rosemont, Pa.
1932. Porter, Roland De Lance, Jenkintown, Pa.
1931. Pryor, Charles Allen, 1910 Spruce St.
1931. Ramsey, Frank M., Chestnut Hill.
1913. Randall, Alexander, 136 S. 16 Street.
1941. Rankin, Charles A., 1930 Chestnut St.
1926. Ravdin, I. S., Univ. of Pa. Hospital.
1941. Rea, Marion Hague, 141 Montgomery Ave., Bala-Cynwyd, Pa.
1938. Read, Hilton Shreve, 5407 Atlantic Ave., Atlantic City, N. J.
1928. Reese, Warren S., 1901 Walnut St.
1925. Reeves, Rufus S., 2227 Spruce St.
1920. Rehfuss, Martin E., 131 St. George's Rd., Ardmore, Pa.
1921. Reiff, E. Paul, 1927 Spruce St.
1937. Reimann, Hobert A., Jefferson Hospital.
1919. Reimann, Stanley P., The Lankenau Hospital Research Institute, Girard and Corinthian Aves.
1929. de Rényi, George S., 212 S. 39th St.
1923. Repplier, Sidney J., 373 Roumfort Rd., Mt. Airy.
1936. Richards, James L., Haverford Villa, Ardmore, Pa.
1919. Richardson, Russell, 320 S. 16th St.
1919. Ridpath, Robert F., 1737 Chestnut St.
1942. Riggs, Helena E., 37 S. 20th St.
1936. Ritter, Joseph A., 2405 N. 54th St.
1933. de Rivas, Damaso, 1831 Chestnut St.
1932. Robbins, Frederick R., 255 S. 17th St.
1939. Roberts, Ella, 133 S. 36th St.
1899. Roberts, Walter, 1921 Spruce St.
1932. Robertson, Harold F., 327 S. 17th St.
1903. Robertson, William Egbert, 327 S. 17th St.
1938. Roche, Philip Q., 255 S. 17th St.
1912. Rodman, John Stewart, 1726 Spruce St.
1934. Rogers, Harry L., Riverton, N. J.
1928. Rose, Edward, Univ. of Pa. Hospital.
1936. Rose, Elizabeth Kirk, 426 Owen Rd., Wynnewood, Pa.
1909. Rosenberger, Randle C., Rahns, Pa.
1932. Rothrock, Harry A., West Chester, Pa.
1936. Rothschild, Norman, 245 S. 16th St.
1933. Rowntree, Leonard George, 1520 Spruce St.

1937. Roxby, John B., Dept. of Anatomy, Temple University.
1941. Royster, Hubert A., Jr., Mermont Apts., Bryn Mawr, Pa.
1933. Rudolphy, Jay Besson, 230 S. 21st St.
1905. Rugh, J. Torrance, 136 S. 16th St.
1929. Ryan, William J., 136 S. 16th St.
1936. Sands, Joseph Evans, Rosemont, Pa.
1905. Sartain, Paul J., 2006 Walnut St.
1908. Sautter, Albert C., Germantown Professional Bldg.
1927. Saxon, Gordon J., 5314 Spruce St.
1920. Scarlett, Hunter W., 230 S. 21st St.
1939. Scattergood, Joseph, Jr., 115 S. High St., West Chester, Pa.
1917. Schaeffer, J. Parsons, 4634 Spruce St.
1932. Schaffer, Howard W., 269 S. 21st St.
1929. Scheffey, Lewis C., 255 S. 17th St.
1942. Scheie, Harold G., 4300 Spruce St.
1929. Schenck, Harry P., 1912 Spruce St.
1917. Schnabel, Truman G., 1704 Pine St.
1917. Schoff, Charles H., Media, Pa.
1928. Schofield, Frederick S., 136 S. 16th St.
1921. Schumann, Edward A., 1814 Spruce St.
1930. Scott, John Porter, 1740 Bainbridge St., The Children's Hospital.
1940. Scott, T. F. McNair, 315 Pelham Road, Germantown.
1917. Service, Charles A., Bala, Pa.
1924. Shallow, Thomas A., 1611 Spruce St.
1908. Shannon, Charles E. G., 1930 Chestnut St.
1928. Sharpe, John S., Haverford, Pa.
1928. Sharpless, Frederick C., Rosemont, Pa.
1897. Sharpless, William T., West Chester, Pa.
1931. Sheehan, William C., 8314 Germantown Ave.
1932. Sheridan, Joyce T., 412 W. Durham St.
1906. Shields, William G., 414 School Lane, Germantown.
1936. Shipman, James Shelby, 255 S. 17th St.
1935. Shoemaker, Robert, 3rd, 68 Byberry Rd., Hatboro, Pa.
1896. Shoemaker, William T., 2017 Locust St.
1939. Shumway, Norman P., Rittenhouse Plaza.
1936. Shuster, Benjamin H., 1824 Pine St.
1941. Silcox, Louis E., 1520 Spruce St.
1903. Sinclair, John F., 4103 Walnut St.
1907. Sinkler, Francis W., 136 S. 16th St.
1928. Skillern, Samuel R., 1734 Pine St.
1933. Smelzer, Donald Campbell, Germantown Hosp., Penn and Chew Sts.
1929. Smith, Austin T., 259 S. 17th St.
1933. Smith, Lauren Howe, 111 N. 49th St.
1937. Smith, Lawrence Weld, Temple School of Medicine.
1936. Smith, Richard Manges, 4727 Oakland St.
1927. Smyth, Calvin Mason, 136 S. 16th St.
1919. Smyth, Henry Field, Box 232, Pocassett, Mass.
1941. Snyder, G. Gordon, Mermont Apts., Bryn Mawr, Pa.
1935. Sokoloff, Martin J., 255 S. 17th St., Phila.
1940. Soloff, Louis A., 2032 Pine St.
1935. Sommer, George N. J., 120 W. State St., Trenton, N. J.
1928. Spaeth, Edmund B., 1930 Chestnut St.

1937. Spangler, John Luther, Devon, Pa.
1935. Spiegel, Ernest, 6807 Lawnton Ave., Oak Lane.
1929. Sponsler, Marshall B., 1934 Spruce St.
1894. Stahl, B. Franklin, Haverford, Pa.
1909. Starbuck, J. Clinton, 42 East Washington St., Media, Pa.
1927. Starr, Isaac, 505 Cresheim Valley Rd.
1936. Steinfield, Edward, N.E. Cor. 18th and Chestnut Sts.
1942. Stengel, Alfred, Jr., 255 S. 17th St.
1901. Stevens, Arthur A., 314 S. 16th St.
1914. Stewart, Thomas S., The Barclay, 18th and Rittenhouse Sq.
1941. Stewart, Winifred B., 2028 Delancey St.
1931. Stiles, Merritt H., 113 W. Chestnut Ave., Chestnut Hill.
1934. Stimson, Cheney M., 167 Harvey St., Germantown.
1925. Stokes, John H., 4228 Spruce St.
1928. Stokes, Joseph, Jr., 1740 Bainbridge St.
1923. Strecker, Edward A., 111 N. 49th St.
1923. Stroud, William Daniel, 1011 Clinton St.
1937. Strumia, Max M., Bryn Mawr Hospital, Bryn Mawr, Pa.
1933. Stuckert, Harry, 248 S. 21st St.
1937. Sturgis, Margaret C., 1930 Chestnut St.
1927. Sturgis, Samuel Booth, 34 W. Montgomery Ave., Ardmore, Pa.
1934. Summey, Thomas J., 255 S. 17 St.
1930. Sunderman, F. William, 2210 Delancey St.
1936. Surver, James Miller, 1832 Spruce St.
1928. Swartley, William B., 6002 Greene St.
1934. Sweeney, John A., 1900 Rittenhouse Sq.
1933. Taylor, Herbert W., Haverford, Pa.
1931. Taylor, Norman H., 100 W. Evergreen Ave.
1928. Thomas, J. Earl, Drexel Hill, Pa.
1907. Thomas, T. Turner, 1636 Francis St.
1927. Thorington, J. Monroe, 2031 Chestnut St.
1898. Thornton, Edward Q., 1331 Pine St.
1936. Thornton, Mary Bickings-, 2703 West Somerset St.
1936. Thorp, Francis Quicksall, 4900 Penn St.
1930. Thorpe, Edward S., Jr., School of Medicine, Univ. of Pa.
1936. Thudium, William J., 136 S. 16 St.
1935. Tocantins, Leandro Maués, 45 Woodale Rd.
1935. Toland, Owen J., Episcopal Hospital, Front and Lehigh Ave.
1941. Tompkins, Pendleton, 255 S. 17th St.
1936. Towson, Charles Emory, Germantown Professional Bldg., Phila.
1934. Tracy, Martha, Woman's Medical College, Phila.
1908. Tracy, Stephen E., 1930 Chestnut St.
1926. Tucker, Gabriel, 326 S. 19th St.
1938. Tuft, Louis, 1530 Locust St.
1933. Tumen, Henry J., 1900 Rittenhouse Sq.
1938. Turman, Christopher M., Wyncote, Pa.
1935. Turnbull, William G., Phila. General Hospital.
1923. Turner, Creighton H., 1731 Pine St.
1929. Tyson, Ralph M., 255 S. 17th St.
1937. Uhle, Charles A. W., 255 S. 17th St.
1907. Ullom, Josephus T., Carpenter and Quincy Sts.
1934. Ulrich, George A., 309 S. 12th St.

1937. Vander Veer, Joseph B., 302 S. 19th St.
1937. Van Loon, Emily Lois, 1930 Chestnut St.
1933. Vastine, Jacob H. 2nd, 136 S. 16 St.
1912. Vaux, Norris Wistar, 807 Spruce St.
1940. Voegelin, Adrian W., 1521 Lindley Ave.
1941. Vogel, Stoughton R., 246 W. Walnut Lane, Germantown.
1903. Wadsworth, William S., 3914 Baltimore Ave.
1927. Wagers, Arthur J., 1429 Spruce St.
1928. Wagoner, George W., Haverford Gables, Haverford, Pa.
1938. Waldman, Joseph, 1930 Chestnut St.
1906. Walker, John K., Media, Pa.
1907. Walker, Warren, 1819 Chestnut St.
1932. Walkling, Adolph A., 136 S. 16 St.
1904. Walsh, Joseph, 136 S. 16 St.
1895. Watson, Arthur W., 2013 Locust St.
1932. Watt, Charles C., Jr., 6605 Wayne Ave.
1933. Waygood, James Jamison, 3464 School Lane.
1941. Weaver, Ruth H., 1719 Rittenhouse Square.
1903. Weber, Charles H., 3 Arch Bay, Laguna Beach, Cal.
1930. Weeder, S. Dana., 6110 Greene St.
1920. Weidman, Fred D., 20 Tenby Rd., Llanerch, Pa.
1933. Weiss, Benjamin P., The Lenox, 13th and Spruce Sts.
1923. Weiss, Edward, 269 S. 19th St.
1935. Whelan, G. L., 2100 Walnut St.
1921. Whitaker, William, 5448 Germantown Ave.
1936. White, Ellen Pawling Corson-, 1820 Pine St.
1925. Widmann, Bernard P., 250 S. 18th St.
1936. Wilder, Theodore S., Germantown Professional Bldg., Greene and Coulter Sts.
1936. Wilkinson, Richard Powers, 1613 S. Broad St.
1914. Willard, De Forest P., 1726 Spruce St.
1935. Willard, John Harrington, 2022 Locust St.
1939. Willauer, George, 1930 Chestnut St.
1907. Williams, Carl, School Lane and Greene St.
1924. Williams, Horace James, 5908 Greene St., Germantown.
1937. Williams, John C., 6370 Germantown Ave.
1920. Williams, Philip F., 2206 Locust St.
1927. Williamson, Ernest G., 6353 Woodbine Ave.
1916. Wilmer, Harry Bond, 138 W. Walnut Lane, Germantown.
1921. Wilson, George, 133 S. 36th St.
1942. Wilson, Lucius R., 323 Cherry Bend, Merion, Pa.
1937. Wilson, Ross B., 1820 S. Rittenhouse Sq.
1902. Wilson, Samuel M., 1930 Chestnut St.
1897. Wilson, W. Reynolds, Villa Nova, Pa.
1940. Winchell, A. Vaughn, 3432 Powelton Ave.
1941. Wirts, C. Wilmer, 2017 Delancey St.
1904. Wister, James W., 5430 Germantown Ave.
1933. Wohl, Michael G., 1727 Pine St.
1918. Wolferth, Charles C., 26 Raynham Rd., Merion, Pa.
1942. Wolman, Irving J., Children's Hospital, 1740 Bainbridge St.
1893. Wood, Alfred C., 2035 Walnut St.
1932. Wood, Francis C., Laurel Lane, Haverford, Pa.
1900. Wood, George B., N.E. Corner 20th and Chestnut Sts.

1903. Wood, Horatio C., 319 S. 41st St.
1897. Woodward, George, W. Willow Grove Ave., Chestnut Hill.
1928. Wright, Carroll S., 1402 Spruce St.
1937. Yaskin, Joseph C., 1832 Spruce St.
1941. Young, Barton R., 8327 Roberts Road, Elkins Park, Pa.
1894. Zentmayer, William, 1930 Chestnut St.
1895. Zimmerman, Mason W., 1518 Waverly St.
1933. Zulick, J. Donald, 2008 Walnut St.

Non-Resident Fellows

ELECTED

1903. Biggs, M. H., Rutherfordton, N. C.
1937. Braceland, Francis J., Loyola Medical School, 706 Wolcott Ave., Chicago, Ill.
1936. Brown, Clark E., Dept. Pathology, University of N. Carolina, Chapel Hill, N. C.
1908. Cadbury, William W., 260 E. Main St., Moorestown, N. J.
1936. Camero, Anthony R., 657 S. Westlake Ave., Los Angeles, Cal.
1936. Clarke, Francis Mann, 116 New St., New Brunswick, N. J.
1937. Conaway, W. P., 1723 Pacific Ave., Atlantic City, N. J.
1936. Cooper, Melbourne J., Nix Professional Building, 414 Navarro St., San Antonio, Texas.
1897. Dorland, W. A. Newman, 4512 Sheridan Road, Chicago, Ill.
1905. Evans, Joseph S., Jr., 1300 University Ave., Madison, Wis.
1933. Fowler, Kenneth, 880 Fidelity Medical Bldg., Dayton, Ohio.
1935. Fretz, John Edgar, "Hillcrest" College Hill, Easton, Pa.
1913. Gates, Nathaniel, 10 Peterboro, Detroit, Mich.
1936. Guthrie, Donald, 118 S. Wilbur Ave., Sayre, Pa.
1902. Gwyn, Norman B., 109 Madison Ave., Toronto, Canada.
1928. Hayman, Joseph Marchant, Jr., Lakeside Hospital, 2065 Adelbert Road, Cleveland, Ohio.
1892. Hinsdale, Guy, White Sulphur Springs, W. Va.
1933. Hitzrot, Lewis H., Medical Director, Mercersburg Academy, Mercersburg, Pa.
1936. Hughes, Brady A., 5005 42d Place, North, Birmingham, Ala.
1912. Hunter, John W., McDaniel, Md.
1885. Jackson, Edward, Republic Building, Denver, Colorado.
1900. Jopson, John H., Waverly Mills, S. C.
1887. Kelly, Howard A., 1418 Eutaw Place, Baltimore, Md.
1932. Landis, Eugene M., 34 University Circle, Charlottesville, Va.
1935. McGuire, Hunter H., 105 N. Braddock St., Winchester, Va.
1900. McReynolds, Robert Phillips, 213 S. Broadway, Los Angeles, Cal.
1936. Middleton, William Shainline, State of Wisconsin General Hospital. Madison, Wis.
1915. Musser, John H., 1430 Tulane Ave., New Orleans, La.
1937. Nicholson, Samuel T., 2d, The Hill School, Pottstown, Pa.
1905. Norris, George W., Dimock, Pa.
1899. Parke, Wm. E., 5637 LaGorce Drive, Miami Beach, Florida.
1926. Paul, John Rodman, Dept. Internal Medicine, Yale University, New Haven, Conn.
1907. Price, George E., Stimson Bldg., Seattle, Wash.
1904. Ravenel, M. P., 203 Westmont Ave., Columbia, Mo.
1936. Reisinger, John A., 7500 Bybrook Lane, Chevy Chase, Md.
1907. Royer, B. Franklin, The Hall, R. D. 7, Chambersburg, Pa.
1913. de Schweinitz, George L., 85 E. Broad St., Bethlehem, Pa.
1941. Shands, Alfred R., Jr., 603 Delaware Trust Bldg., Wilmington, Del.
1908. Shoemaker, Harlan, 1930 Wilshire Blvd., Los Angeles, California.

1932. Siegel, Alvin Erdreich, Medical Arts Building, Macon, Ga.
1933. Southworth, Varnum C., 138 Race St., Cambridge, Md.
1934. Stewart, Sloan G., Pacific and N. Carolina Aves., Atlantic City, N. J.
1900. Swan, John M., 457 Park Ave., Rochester, N. Y.
1913. Vail, William Penn, Blairstown, N. J.
1897. Veasey, Clarence Archibald, 1569 Paulsen Medical and Dental Bldg., Spokane, Washington.
1931. Walker, Herschel Carey, Hampshire House, 150 Central Park South, New York City.

Honorary Fellows

Limited to Fifty, of Whom Twenty May be Foreigners

American

ELECTED

1909. Crile, George W., M.D., Cleveland Clinic, Euclid Ave. at E. Ninety-third St., Cleveland, O.
1917. Miner, Charles Howard, B.S., M.D., Member of Board of Directors, Wilkes-Barre General Hospital; Board of Health, Wilkes-Barre; Board of Directors, White Haven Sanitarium Association and Penna. Tuberculosis Society. 264 S. Franklin St., Wilkes-Barre, Pa.
1936. Richards, Alfred Newton, PH.D., SC.D., M.D. (HON.), L.L.D., Professor of Pharmacology, School of Medicine, Vice-president in charge of Medical Affairs, Univ. of Pa. School of Medicine, Univ. of Pa., Phila.

Foreign

1928. Archibald, Edward, M.D., McGill University, Montreal, Canada.
1937. Dale, sir Henry Hallett, C.B.E., F.R.S., M.A., M.D., F.R.C.P., Director, National Institute for Medical Research, Hamstead, Eng. Mt. Vernon House, N.W. 3, Hamstead, London.
1924. Hopkins, Sir F. Gowland, M.D., Biochemical Department, University of Cambridge, Cambridge, England.
1922. McCarrison, Sir Robert, K.T., C.I.E., M.D., D.SC., LL.D., F.R.C.P., Major-General, Indian Medical Service (retired). 18 Linton Rd., Oxford, England.
1928. Rolleston, Sir Humphrey, BART., G.C.V.O., K.C.B., M.D., D.C.L. (*Durh.*), LL.D., D.SC., Martins, Haslemere, Surrey, England.

Necrological List

Resident Fellows

	Date of Election	*Date of Death*
Arthur Newlin	April, 1905	April 13, 1941
Henry K. Mohler	October, 1921	May 16, 1941
John J. Shaw	March 5, 1941	June 24, 1941
James E. Talley	January, 1900	July 3, 1941
J. P. Crozer Griffith	January, 1883	July 28, 1941
Henry Barr Ingle	October 6, 1937	August 10, 1941
Isador Kaufman	January, 1926	August 11, 1941
E. Hollingsworth Siter	December, 1902	September 5, 1941
Edward A. Shumway	March, 1900	December 19, 1941
Herbert Fox	May, 1908	February 27, 1942

Non-Resident Fellows

A. Graeme Mitchell	November, 1917	June 1, 1941
Henry Norris	November, 1901	October 6, 1941
William H. Bell	June, 1916	November, 1941

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Fatigue*

By ARLIE V. BOCK, M.D.

Henry K. Oliver Professor of Hygiene, Harvard University

WEIR MITCHELL was the first American physician to emphasize, in a little volume published in 1871, the nature of wear and tear. "Wear," he wrote, "is a natural and legitimate result of lawful use, and is what we all have to put up with as the result of years of activity of brain and body. Tear is another matter. It comes of hard or evil usage of body or engine, of putting things to wrong purposes, using a chisel for a screwdriver, a penknife for a gimlet. Long strain, or the sudden demand of strength from weakness causes tear. Wear comes of use; tear from abuse." Seventy years ago Weir Mitchell was alarmed because of the over-taxed nervous systems of certain classes of Americans, chiefly of the crowded portions along the Atlantic seaboard. "If the strictures I have to make applied throughout the land—to Oregon as to New England, to the farmer as to the business man, to the women of the artisan class as to those socially above them—then indeed I should cry, 'God help us and those that are to come after us!' " Today I fear Mitchell's strictures would apply from coast to coast and few indeed have paused to consider the causes of the harvest we are now reaping.

The term "fatigue" means all things to all men. Its significance ranges all the way from metaphysical concepts to the realm of stark reality. No state of the human body is mentioned more often than that of fatigue and none covers a greater range of stimuli through which it may be produced. None of us are free for long from some of its manifestations. It would be an easy and pleasant task to discuss fatigue from the standpoint of known physiological data, laboriously obtained through the work of many hands, but as soon as we look at the subject from a clinical point of view the intangible nature of fatigue involves us in a consideration of most of the reactions of the body to daily living. The list of things we know is short against the vast area still to be explored. I ask your indulgence while I attempt to visualize some of the complexities of a subject in which most of you are involved in the daily practice of medicine. If anything is certain, it is that we have no drug, no vitamin, no simple panacea to offer the nation or our patients concerning the problem of fatigue.

We may begin by a brief review of familiar types of fatigue. The sprinter is exhausted at the end of a 100-yard dash, due primarily to oxygen debt. In contrast, at the end of a marathon race, the runner has used up most of his available energy reserve. The steelmill worker, performing hard work in external temperatures of 120° or higher, may break down primarily through loss of body fluids and salt. The mountaineer at high altitudes becomes fatigued because of low oxygen pressure in the atmosphere. The aviator in war time, in addition to low oxygen pressure, suffers from a

* James M. Anders Lecture XIX, The College of Physicians of Philadelphia, April 1, 1942. Owing to war duties, D. Bruce Dill, Ph.D., Director, Fatigue Laboratory, Harvard University, was unable to participate, as scheduled, in the presentation.

complicated array of other fatiguing stimuli now urgently calling for solution. In this connection anoxia at high altitudes is important, but if our investigations concerned with fatigue in pilots deal only with this question we may well lose the war. Perhaps even less understood is the fatigue of the housewife, due to care of the household, bearing and supervision of children, preparation of food and a host of other obligations. The laborer, the business man, professional man, student, teacher, soldier, sailor—all feel to some degree the ravages of fatigue. The idle suffer from fatigue if idleness becomes sufficiently prolonged. The causes of fatigue are thus extraordinarily variable and so are its manifestations. As Bruce Dill has pointed out, the only characteristic common to all forms of fatigue is the discrepancy between the processes of wear and repair.

In studying the problem of fatigue the physiologist can measure the rate of production and disappearance of lactic acid, follow changing levels of blood sugar, blood pressure, pulse rate, and observe numerous other phenomena in blood, urine and sweat. In no case of fatigue however produced in the intact organism, can the full story of all the events transpiring be written. We are comparatively well advanced in the study of muscle physiology. We know some important things about physio-chemical equilibria in the body, but the rôles played by the nervous system and the psyche—if we may think of this apart from the nervous system, in causing fatigue—are for the most part matters of experience rather than definite knowledge. As doctors, it is true that we are concerned with problems of nutrition, hours spent at work, and nature of the work performed, but in the long run we presume that psychological and sociological factors are the elements most concerned in production of the fatigue from which the nation in general suffers.

From a clinical point of view awareness of the nebulous nature of our understanding of fatigue is part of the daily experience of those who attempt to deal with it. While fatigue is usually the first symptom mentioned by the patient to his doctor, we are handicapped in any discussion of the subject because we do not know from a scientific point of view what fatigue is. In view of the nature of some of our work in Cambridge I am often asked to give a definition of what is meant by the term "normal person." The only reasonable answer at present is that the expression carries with it a concept of normality held by each of us but differing in quality as our experience and understanding differs. In the same manner we have a concept of fatigue but to this concept we can give no precise definition. Furthermore, resistance to fatigue or precipitation of it under what appear to be identical conditions varies from individual to individual and may change with age and other factors not readily recognized. Fatigue is a common product of various organic diseases, of undernutrition, of lack of physical conditioning, but in its most general forms appears to be a physiological disturbance not necessarily accompanied by organic changes. If long continued it may lead to organic disease and forms, as we now believe, the background upon which many acute and some chronic ailments of the race are planted.

The speaker has not only the difficulty of attempting to discuss a subject for which we possess no adequate definition, but there is also the serious barrier set up by many physicians who fail to consider fatigue as a close ally of many conditions they are called upon to treat. In the busy rush of daily practice the tendency too often is to think in terms of the specific derangement instead of the derangement plus the person who is suffering. An over-all look at the patient as a person—including his way of living, his family, his problems, his anxieties, the pressures under which his life is spent—provides the main source of our clinical knowledge of what fatigue is and the effects it may produce in human beings.

I have nothing new to offer you in a discussion of this elusive subject but shall ask you to follow the point of view from which I look at all patients, irrespective of the specific or non-specific ailment under consideration. Aside from a category of events over which we appear to have little control, such as cancer, leukemia, the ageing process, gall stones, epidemic diseases, etc., I find it difficult indeed to separate the rest from having a direct relation to the way of life of the individual. Not being a psychiatrist, I am not preoccupied by Oedipus and other complexes, nor do I believe that the experiences of the first five years of life—nor the first twenty, for that matter—necessarily set the pattern from which there is no escape save by psychoanalysis. As physicians we are greatly indebted to psychiatry, sufficiently to enable us in practice to eliminate the need of psychiatrists for incipient stages of trouble for all but a very small number of our patients, if we take a realistic

view of things and act upon our knowledge. If we are prepared to take advantage of some of the principles of psychology and psychiatry and of our knowledge of people in general, we can attack at their very initiation many states that through neglect or indifference lead to sorrow if not to chronic invalidism. Because of failure of a sensible program, in which all of us, doctors and public alike, are involved, we ask magic from our colleagues in psychiatry. I propose to discuss results of everyday events happening to people in the ordinary walks of life.

For our purpose we may define fatigue as the product of the summation of stimuli for which the total organism does not make adequate daily compensation. In this sense the terms "fatigue" and "anxiety" may be used synonymously. Breakdown results, called fatigue by all of us, which may have no other expression than inability of the person to carry on the day's work, or may provide the soil for that vast variety of intangible symptoms brought to the attention of doctors every day, or may crystallize in such states as hyperthyroidism, many cases of hypertension, ocular neurosis, duodenal ulcer, ulcerative colitis, chronic indigestion, dermatitis, so-called sinusitis, backache, often repeated respiratory infections, rheumatoid arthritis, simulation of bowel obstruction, frequent and varied types of cardiac disorder, etc.

At the present time there are no adequate physiological tests by which this type of fatigue may be measured. We think in terms of personality types in the case of duodenal ulcer, ulcerative colitis, and a few other conditions, but we know little enough about these and almost nothing of the vagaries of the autonomic system, of devious changes to which the germ plasm may be subjected, and of the chemical or humoral responses that we believe may be operating in tired-out people. Our ignorance in these matters is partially offset by clinical experience which shows that much may be accomplished in relief if we recognize constantly that we are dealing with a person, not a stomachache. The prescription reflex so highly developed by doctors should be controlled, for the most part, by a very long latent period. In its stead should come understanding of the pressures under which the patient lives his life. What are his fears, anxieties, insecurities? Remorse, lack of independence, failure to achieve or have achievements recognized, unhappy family life, the whole train of events leading to worry and unhappiness—understanding of these is the prime concern of the doctor, the educator, the economist, the industrialist, and the government expert. Because of the wide-spread implications of these important matters, no one may delude himself long about the virtue of what is called socialized medicine, apart from all of the other considerations involved in the organization and maintenance of a sound and healthy society.

In a physiological sense, fatigue is a natural product of use of the body. It has well known advantageous purposes. Recovery from it restores a sense of well-being made more estimable by contrast with the tired state. Pathological fatigue is another matter. It comes from strain, from lack of experience, from striving for ends beyond reach, from demands upon organisms unfit or unprepared to meet them. In many cases we have only surmise concerning its origin and in no case can we have all of the facts at the present time.

A better perspective of our present problem may be gained if we may make a brief survey involving rather large numbers of people. Why, among undergraduates at Harvard College, should the highest rate of incidence of illness fall among the young men of the freshman class? And among graduate students, why does the rate of illness in medical students exceed that occurring in any other graduate school of the University? There is no simple answer but I should like to refer to some possible relationships:

For the majority of freshmen, the problems of adjustment incident to starting a college career lead to states of worry and frustration accompanied by fatigue, frequently associated with the development of respiratory infections or other manifestations of illness. Often repeated respiratory infections or the complaint of chronic sinusitis are accepted by us as prima-facie evidence of maladjustment, or if you like the term better, of unhappiness. The struggle to survive in a large community, to get on with one's fellows, to organize and make effective use of time, to achieve independence, to obtain necessary funds, to retain a scholarship—these are the types of experiences through which only comparatively few come without falling heir to trouble of one kind or another. The results as we see them are only in part due to local conditions. For a more complete answer one must know more about heredity and prior conditioning influences.

In the Harvard Medical School last year 42 per cent of 527 men were admitted to the Infirmary or

to the teaching hospitals of the Medical School. The annual cost of medical care of medical students is greater than for students of any other division of the University. This is in part due to the cost of various techniques applied in the routine examinations of medical students not commonly made with other students, but is in large part due to the volume of illness. The usual explanation given is that medical students work hard and that they are more exposed to illness. These are probable factors as in the case of tuberculosis, but I wonder about the rôle played by apprehension and introspection in a field in which, to cite one example, many students are apt in their thinking to have the disease last encountered in a patient. What appears to be needed is a more objective type of approach both to work and living in which the individual may separate himself more successfully from the problems he is called upon to consider. In contrast with college freshmen and medical students, the group of athletes and outstanding men in the R.O.T.C. are admitted to hospital or infirmary mainly for treatment of trauma.

In this connection, the following data are not without interest. From 1935 to 1941, 372 appendectomies were performed in Harvard students—a rate of 7.85 per thousand, the age groups ranging approximately from 17 to 26 years. Among freshmen the rate per thousand was *12.6*, for seniors 8.5, for law men 6.5, for men in the Business School 3.9, and for medical students *9.6*. All students in the University have approximately equal opportunities for consulting a physician and our records show they do so with extraordinary frequency. Is this experience with appendicitis the result of mere chance, or does it have some bearing on the question of fatigue? It may be shocking to some of you to think of appendicitis in this connection but under some circumstances, at least, you may find the concept not beyond consideration.

In another area and on a much larger scale, reports from England indicate that most of the common run of complaints for which people in peacetime sought advice from physicians have largely disappeared, as was the case, also, in World War I. There is now for the people of England a great objective to be gained with less time for the personal worries, introspections, and preoccupations which so often lead to grief, despair, and illness. Hundreds of thousands, if not millions, of people have suddenly, through the exigencies of war, found their place in the sun. Participation in the common cause has provided for the time being new interests, new satisfactions, new communal endeavors. Recession of illness under these circumstances suggests a good sense of well being for the people without which a high standard of health is not possible. A crude but poignant reminder of this same effect on a national scale is the barometric rise of the suicide rate with bad times and fall of this rate with return of better days.

In the field of labor, Britain, after Dunkerque, forgetting the lesson of the last war, started factories and mills working twenty-four hours a day, seven days a week, with no holidays. After a period of only two months of such effort, absenteeism began to increase, men arrived late for work, and production began to fall off. Investigation of the problem brought forward a recommendation that the weekly maximum of work in all industries should be not greater than fifty-five hours. Any defense program must take into account time for diversion, sport, and the kind of social contacts to which people have become accustomed. In their interesting book, *Management and the Worker*, Roethlisberger and Dickson show that social implications both in and out of the factory have an important bearing on work performance. The boredom of routine work and the relatively small demand on energy output except in the heavy trades, must be offset by suitable social outlets for relaxation and other forms of enterprise appealing to the spirit of man. Grim application to work alone has been known for ages to depress body and soul.

When we turn to consideration of the welfare of the individual the significance of the origin of his complaints is too often overlooked. We must remember that he is a member of a family; he may be responsible for the support of the family; the family is part of the community, and subject in many ways to the reactions of the community. The community has been subjected to experiences in the '40s undreamed of in 1910. Each of us, especially those charged with the welfare of many people, assumes daily responsibility at a rate which must be two or three times that expected of our grandfathers. With offices equipped with typewriters, filing systems, telephones; with automobiles and aeroplanes at our disposal, the pace of living has forged onward, but the basic qualities of our nervous system remain unchanged. To possess an automobile many families deprive themselves of home comforts and even food that would

otherwise be available. Home in general is not what it was one or two generations ago. The nightly jam at movie theatres and other public resorts means rest and enjoyment for some people, but for many it reflects an unsuccessful escape from the trials and burdens of the day. Thrift has gone, social security has come; labor, not business, is in the saddle. As physicians our opinions about various aspects of this social upheaval apparently matter little, but the impact of social changes upon the nature of medical practice is of great concern. We have no figures from 1910 to contrast with 1940, but it is the impression of doctors everywhere that the number of nervous, tired-out people has increased greatly within this period. Fatigue has become an omnipotent factor, not to be left out of consideration in nearly every patient who consults us.

The well known influences of the rôle of fatigue in common states such as hyperthyroidism, duodenal ulcer, various types of neuroses, etc., have frequently been discussed. We must, however, broaden our vision with reference to one condition after another. For example, congestive failure in a patient with rheumatic heart disease may occur not primarily due to structural changes of heart valves or to the activation of rheumatic fever, but to a wearing down process of the whole organism through worry. Prognosis may be greatly altered if effective changes, beyond those involved in the usual medical routine, can be instituted. Some cases of bronchial asthma cannot be cured without readjustment of sources of anxiety. When latent migraine or latent epilepsy becomes overt the events of the preceding months or years must be understood by the physician if these difficulties are to be controlled properly. Not a few cases of angina pectoris are better treated by removing causes of fear than to depend upon the use of nitroglycerine and a restricted life. Extraordinary cases of dermatitis are going from one dermatologist to another for want of understanding of the rôle played by problems of living, as Stokes has pointed out. Many symptoms assigned to conditions in the nose, sinuses, and throat are made worse rather than better by operative procedures. The symptoms here may be referred to the head as the symptoms of an ocular neurosis are referred to the eyes, but the source of the trouble lies elsewhere. Examples of like kind and doubtless many others will have passed through your minds as I speak.

In their paper dealing with 1500 cases of recurrent peptic ulcer, Brown and Dolkart (1) concluded that "functional nervousness including fatigue and anxiety, was by far the greatest detectable cause of recurrence," and in many cases that the same causes might be responsible for the original ulcer. They say, "treat first the patient, second the bowel, and last the ulcer." Certainly most physicians agree with these conclusions. Too often, however, we have not recognized the rôle played by fatigue in the persistence of pylorospasm, to take one complication, in the presence of ulcer. Frightened by nasal tubes and other paraphernalia in hospital, without being given an opportunity to understand the rôle played by fear in producing gastric retention, the result may lead to gastric resection instead of alleviation through relatively simple procedures dealing with man's understanding of man.

It is perhaps futile to recount in detail the story of the development of any of these conditions, but I should like to dwell for a moment on one type of particular interest to me in which fatigue engendered by pressure of living and fear accounts in large part for the symptomatology, and as I think, for the premature development of organic changes. There is a group of high-strung, high pressure men in the forty's and early fifty's who suffer from repeated daily attacks of angina pectoris. The attacks almost invariably occur under given conditions, such as while shaving, while stooping over to tie shoe strings, on opening a given door, on receipt of perplexing news, on walking a certain distance to a given street corner. These patients show little abnormality on physical examination, by X-ray examination, or by electrocardiographic changes. They have usually been frightened by instructions from physicians to restrict all activities and to use vasodilator drugs. They go on for many, many years suffering from fear of impending death. It appears likely that, in the beginning of the history of attacks, there may be minimal coronary sclerosis present. An attack of pain having occurred in this type of hypersensitive intelligent person, the repetition of attacks seems to me to be due to a conditioned reflex, the trigger of which is fear of repetition of pain. Release from this syndrome can be obtained usually only through resolution of fear, restoration of confidence, rest through a holiday, and finally resumption of activity, including golf or other abandoned simple forms of recreation.

We have all wondered about the rôle of wear

and tear in the production prematurely of coronary artery sclerosis. Levy's (2) evidence a few years ago gave little credence to the idea but on the basis of clinical observation alone one cannot easily dismiss the relationship. Heberden, in his original paper, 1768, mentions that angina pectoris is increased by disturbances of the mind. The apparent increasing incidence of coronary sclerosis in America seems to run parallel with the changes wrought by the New Era, the New Deal, and other influences. Widespread recognition of the diagnosis today as compared with 1910 accounts for much of the statistical increase; mistaken diagnoses of the condition add to the total; but granting these significant factors, I doubt if we can eliminate fatigue as an important causative agent in the precipitation of premature coronary artery sclerosis. We now have the suggestive evidence of Hall (3) concerning the rôle played by acetyl choline in producing coronary sclerosis in normal dogs. Whether we are dealing, in the syndrome of angina pectoris, with chemical mediation of nerve impulses, given a state of fatigue, is not known, but this field is ripe for study as Cannon has in general shown. A similar mechanism may be involved in the production of a pressor substance responsible for essential hypertension which is apparently capable of being dealt with by Page's renal extract (4).

That mechanisms such as these may be real phenomena is suggested by the fact that metabolic changes set up in oarsmen rowing a four-mile race do not subside until approximately seventy-two hours after the race. What is the basis for the sense of well being that comes to each of us in vacation days as compared with the prevacation status? How is it that a man who has been vomiting for three weeks can, on being sent off fishing in Maine, eat baked beans and griddle cakes the morning after his arrival in camp? Excessive stimulation of the cortico-adrenal system, overstimulation of other mechanisms, the nature of which is unknown, challenge our capacity to deal with the mysteries in this field as we have dealt with other areas in medicine.

In view of our ignorance of many matters, it is certain that we as physicians must learn more about the personality structures of our patients if we are to deal adequately with the vast majority of complaints they bring to us. There are reasons, at present unknown, why fatigue appears to precipitate one type of disorder here and another there. The combinations of physical and mental characteristics studied by Draper (5) and others have meaning that cannot be discharged completely by the scepticism of those who will not look and listen. We know now, to take one example, that most patients suffering from rheumatoid arthritis differ in physical characteristics from patients having degenerative joint disease (6). We know, too, that arthritis of any kind is rare indeed among psychotic patients confined to our institutions. In work now going on in Cambridge (7) it is apparent that assymmetries of the body go hand in hand with instability of the whole organism, with histories of unfitness and of excessive illness, suggesting that the germ plasm plays a rôle which some day may be recognized through the veil that now shrouds our knowledge. It is to be hoped that the time will come when we may classify people into groups with reference both to mental and physical characteristics as we now have classifications for disease groups. Then many relationships between illness and the type of person who has the illness may emerge from their present obscurity to help us deal more intelligently both with the person and his illness. Suddenly, owing to the needs of the armed services, the demand is widespread for the means to determine the quality of a man in a five-minute interview. The very core of modern preventive medicine lies in the area of greater understanding of human beings as they go about their daily pursuits. Knowledge gained by the skillful practice of medicine from this point of view should be combined with systematic studies of man which should become established in many of the university centers in the country. Strangely enough we seem to know more about man when he is ill than when he is well. It is fair to suppose that if this paradox were reversed the welfare of the race might be greatly improved.

The psychogenic aspects of fatigue and their relations to illness still await scientific proof. Apparent cause and effect have long constituted the core of wishful thinking. Nevertheless, those who are experts at worry become the most fatigued. Next in line are those who are dissatisfied and unhappy, and last a large group swamped by the dull and dreary grind of daily tasks. We are quick to recognize shell shock in the soldier and sailor. We seem loath to recognize the same or analogous pictures in our patients when they

follow from less dramatic, more insidious factors, slowly but surely at work over the months and years. Some of these influences we can stop, some we can modify, and for some we can teach acceptance. As a people we are victims of time and circumstance. We have too many bad conditioned reflexes; we know too many things that are not so. We are conditioned by fear fostered by commercial advertisers. We have crutches instead of feelings of independence. We have an increasing divorce rate. Emotions rather than reason control our acts. Whenever sound established routines, whether of church or state, are disrupted, as is now the case on a grand scale in Germany, and in their stead are placed chimerical objectives such as *Lebensraum*, disorganization of society follows. We hear much of subconscious motivations but if as physicians we could learn to deal with the conscious field we should greatly relieve the majority of our patients. If we look for causes of unhappiness, using this term in a broad sense, and do what we can to remove them, we shall have done much to relieve fatigue.

In conclusion let me say that if I have appeared to involve most of the range of medical practice in the term *fatigue*, I should like to suggest that we have no alternative but to ascribe to pure coincidence the part it plays in the complex phenomena with which we deal.

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Studies of the Circulation in Congenital Affections of the Heart and their Application to Some of the Problems of Heart Disease*†

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THE OPPORTUNITY of presenting before the College of Physicians of Philadelphia a Mary Scott Newbold Lecture is a great privilege. In accepting this opportunity one is anxious to present to this audience something which is at least partially his own and something which is at least relatively new. I have therefore ventured to bring for your consideration a series of studies of the circulation made in an attempt to elucidate some of the mechanical problems presented by congenital heart disease in patients.

In 1858 when Peacock (1) published a volume entitled "On Malformations of the Human Heart," he inserted in the preface a gentle apology for adding to the literature on a subject which had already attracted so much attention. Since his publication is in some ways a starting point of the modern study of congenital heart disease, perhaps that apology should be renewed by anyone who discusses the problem now.

Since Peacock's publication and in part because of it, the attention which the medical profession pays to congenital heart disease has continued and increased. Maude Abbott (2), to whom much of our current knowledge is due, observes, "the hitherto obscure subject of congenital heart disease is a promising avenue to the understanding of the various cardio-respiratory problems involved and also a field of exceptional clinical interest and significance." Most of the publications concerned with the subject have, properly enough, been concerned with the morphological description of these malformations or with the abnormalities of development which produced them. Speculations about the course of the blood, the volume of its flow, and the pressure in the various circuits have covered acres of paper in the last century or so, but there have been, even in recent years, relatively few data to guide these agreeable lucubrations. One encounters in pursuing these speculative paragraphs the word "obviously," a word that has filled me with distrust since I encountered it in the conversation of a mathematics teacher to whom many things were obvious that were far from clear to me.

The diagnosis of congenital heart disease is not always easy, neither is it always difficult, and its precision has been advanced in recent years by the utilization of new methods (such as the electrocardiogram, the x-ray, and the determination of arterial oxygen) and by a growth of understanding of what Harvey called "the movements of the heart and blood." It is this last aspect of the matter with which this lecture is to deal. We had profited by studying in patients the obstruction to the circulation produced by pericardial disease and the diversion of the blood stream which occurs in arteriovenous fistula and in pregnancy and it seemed that comparable instruction might be gained by an analysis of changes in the circulation of patients with congenital malformations. It seemed important to us to supplement the keen and interesting speculation of the past with *measurements* when these could be made, just as it seemed to us important to control diagnostic conclusions as to morphology with the unanswerable criticism of the autopsy.

The circulation of the blood in man is ordinarily conceived to take place as follows: blood is expelled by the left ventricle into the aorta, it passes thence into finer and finer arterial branches and eventually into capillaries. Here the exchanges with the tissues take place. Leaving the capillaries the blood enters minute venules and passes by larger and larger veins to the vena cava and the right auricle. Entering then the pulmonary circulation it proceeds again by artery,

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capillary and vein to reach the left heart and so complete its circuit.

There are, however, circumstances under which the blood (or part of it) does not describe this usual course but is involved in a by-pass, a shunt, a detour, a short-circuit or a run-around. Occasionally, as the result of trauma or of maldevelopment, we observe a direct connection of artery and vein without the interposition of capillaries. Such connections are referred to as arteriovenous fistulas and, when large, or numerous, produce significant effects upon the flow and distribution of blood. Moreover, such anastomoses between arteries and veins, small but larger than capillaries, are *normally* present in the tissues of many animals including man. Many of the major circulatory changes during pregnancy are associated with a special variety of arteriovenous shunt that leads a large volume of blood through the placenta.

These channels by-pass the capillaries; they join *systemic* arteries to *systemic* veins. There is another group of intervascular links that afford direct connection between *systemic and pulmonary* vessels or between the *right and left sides of the heart*, and thus lead to a mixture of arterial and venous blood. For example a patent ductus arteriosus joins the aorta and the pulmonary artery; septal defects connect the two auricles or the two ventricles. Our attention this evening is directed to this group of abnormal connections leading to a shunt of blood from one circulation to the other.

At first we found it difficult to devise methods that would give us the sought for information. We developed doubts about the applicability of familiar methods, such as those for cardiac output, and in a short time we decided, not to put too fine a point upon it, that we were stuck. We put our notes and diagrams on the shelf and went back to the study of more approachable problems. We dusted off our notebooks from time to time, but not much happened until there was an event which created a new set of opportunities. In 1939 Gross and Hubbard (3) reported the first successful ligation of the patent ductus arteriosus. This brilliant operation was not only a striking advance in therapeutics, but it also gave a new stimulus to the study of congenital heart disease and created a new opportunity for the acquisition of facts about the circulation. It was after the application of this stimulus that Dr. Eppinger and I took up again the problem of the measurement of the circulation in patients with congenital heart disease. The operation introduced by Dr. Gross, and which now has been carried out by him in nearly forty patients, has itself given the opportunity, as will be seen, for the obtaining of evidence in patients. Dr. Gross has also turned his skillful hand to the production in animals of mechanical stituations comparable to those existing in congenital heart disease in patients, and these animals have then been made the subject of investigation. Finally we have continued the patient and systematic observation of people with congenital heart disease—adding or altering methods as we began to understand what the problems were.

It is now proposed to discuss three problems which have interested us in the last two or three years, and through these problems to indicate three modes of approach to the study of congenital heart disease.

We shall begin with the least complete and least satisfactory because it illustrates the take-off of such investigations from the immediate problems of patients. This particular effort is concerned with the elucidation of the mechanism of cyanosis in congenital heart disease. Cyanosis is a deeply impressive sign and the literature is full of good descriptions and shrewd explanations. James Hope (4), writing about one hundred years ago, described the appearance of Mary Collins, aged 8, in these words: "On a frosty day, after walking or ascending stairs, the hue of the parts enumerated as witnessed by myself and several medical friends, is equal to the deep stains communicated to the skin by black currants or the small black cherry, and the face and hands universally are as dark as those of a mulatto. Children in the street often inquired in winter 'where she got blackberries at that season?' ".

Peacock (1), writing in 1858, has this to say about the causation of cyanosis in congenital heart disease: "All modern writers either adopt the exclusive views of Louis and Dr. Stillé that cyanosis depends upon venous stasis; or regard it as partly due to congestion of the venous system and partly to the admixture of the venous and the arterial blood." According to Lundsgaard and Van Slyke (5), the idea of the entrance of venous blood into the arterial circulation goes back to de Senac in 1749 and this extraordinary possibility has fascinated students of heart disease ever since.

The careful analysis of Lundsgaard and Van

Slyke twenty years ago emphasized the veno-arterial shunt as the chief cause of cyanosis, but pointed out the existence of other factors. That sometimes these other factors may be of great importance is brought out by the following experience:

Recently we have studied a young woman with congenital heart disease associated with moderate cyanosis. Up to the age of fourteen she led a life of normal activity. At this time she was told that she had heart disease and about the same time began to note that on occasion, especially after exposure to cold, her face and hands were blue. From that time also dated a limitation of exertion by shortness of breath and occasional transient attacks of faintness. At twenty-three she married and shortly thereafter became pregnant. In the fourth month of her pregnancy she is said to have had an attack of rapid heart beat, which was so alarming that the pregnancy was terminated. At twenty-five she had a series of severe hemoptyses. X-rays at this time showed an area of perihilar infiltration interpreted as tuberculosis. She never had severe dyspnea, orthopnea, edema, or chest pain.

On examination, she exhibited moderate cyanosis. There was some enlargement of the cardiac dulness. An accentuated first sound at the apex was followed by a rather soft systolic murmur. The pulmonary second sound was accompanied by a palpable shock and in the second left intercostal space near the sternum a short, somewhat louder systolic murmur was heard, followed by a diminishing early diastolic murmur. There was no evidence of peripheral congestion. The vital capacity was 3,400 cc. The venous pressure was 58 mm. of water; the arterial pressure 105/70 mm. of mercury. The *oxygen saturation of the arterial blood was 79%.*

Films of the heart showed moderate cardiac enlargement both to the right and to the left, with marked and even extraordinary dilatation of the pulmonary artery and its branches. The right ventricle appeared to be enlarged and the arterial arch was normal. The fluoroscope showed a hyperactive beat with a marked exaggeration of the right ventricle pulsation. The electrocardiogram showed intraventricular block approaching the right bundle branch type.

After much study of this evidence and of the big books we concluded that she had large interventricular septal defect, a dilated pulmonary artery and a "dextro-position" of the aorta, as seen in the patient described by Dr. Eisenmenger (6) of Vienna in 1897. This decision was based on the x-ray evidence of overfilling of the pulmonary circulation, the history of hemoptyses, the evidence of pulmonary insufficiency, and the absence of enlargement of either auricle.

She died suddenly without having developed congestive cardiac failure. An autopsy showed the following situation to exist in her heart: a greatly dilated pulmonary artery, a large defect high in the intraventricular septum, and some displacement of the aorta to the right.

Consider now the factors leading to her cyanosis. It may have been due to the entrance into the aorta of blood from the right ventricle. Let us, in the best tradition of articles on congenital heart disease, speculate about this. The dilated pulmonary blood vessels, resembling those observed in patients with a large interauricular defect, suggest that a large amount of blood is flowing from the left ventricle into the right. The pressures which are known to exist in these two areas make it almost necessary that in the absence of some cause for pulmonary hypertension there should be such a flow from left to right. The cyanosis, on the other hand, which we knew to be due to an arterial unsaturation, suggests that venous blood is going from the right ventricle into the aorta and thus diluting the blood which comes from the left ventricle.

As we talked and thought about this possibility of a shunt, while we were observing this patient during life, we were impressed by the frequent occurrence in the literature of the suggestion that the unusual position of the aorta in relation to the right ventricle would encourage the entrance of right ventricular blood into the systemic circulation. It seems reasonable to think that the larger the opening in the ventricle the more possibility there is of admixture of the contents of the two ventricles and of there developing at least at the end of systole a similar pressure in the two ventricular cavities. Nevertheless, there is every reason to believe that in the absence of some mechanism elevating the pulmonary blood pressure or the resistance to out-flow through the pulmonary valve the pressure in the pulmonary artery will be so much lower than the pressure in the aorta that blood from the right ventricle will enter the pulmonary artery rather than the aorta. Moreover, the size and pulsation of the

pulmonary vessels pointed to a large left to right shunt. These considerations raised a question as to whether the cyanosis might be due to some mechanism other than the right to left shunt we all assumed. If it was not due to such a shunt, an arterial saturation of less than 80 per cent was presumably due to some disorder in the function of the lungs. One possibility was a difficulty in diffusion. It occurred to us that evidence with regard to this question might be obtained by observing the effect of the inhalation of oxygen on the saturation of the arterial blood. It was considered that oxygen unsaturation due to a shunt should not be altered more than minimally by such a procedure. Accordingly this patient was asked to breathe a high oxygen mixture for a number of minutes. At the expiration of this time it was found that the oxygen saturation of her arterial blood had risen from 81 to 92 per cent, that is, it had approached the normal saturation although it had not reached it. This observation seemed to us to indicate that there was some sort of a diffusion difficulty in the lungs and that the shunt, while it might still be present, was less important in the causation of this patient's cyanosis than we had supposed. This conclusion was based on the following reasoning: when cyanosis is due to the entrance of venous blood into the systemic arteries the unsaturation of the venous blood results from the removal of oxygen during its passage through the tissues, and therefore cyanosis may be present however high the original saturation of the arterial blood.

The same idea, we soon found out, had occurred to Campbell, Hunt and Poulton (7), to Paul Meyer (8) and to Talbot *et al.* (9). All three observed the effect of breathing oxygen on the cyanosis of congenital heart disease. The patient of Campbell *et al.* showed a rise in arterial saturation from 67 per cent to 91 per cent; which the observers considered to indicate an abnormality of diffusion in the lung. The diagnosis in their patient was not known. Meyer's patient, believed but not proved to have Fallot's tetralogy, showed no change at all. Talbot's patient, who had autopsy proof of pulmonary atresia, showed only a minimal rise in arterial saturation after being in an oxygen tent for hours. In normal people the inhalation of oxygen elevates the arterial saturation from the normal figure of 95 or thereabouts to 98 per cent or so. In a patient with very severe cyanosis associated with chronic pulmonary disease and cor pulmonale, the inhalation of oxygen completely abolished the cyanosis and raised the arterial saturation from an all-time low of 40 per cent to a normal figure. In several patients with the cyanosis of congenital heart disease (presumably the tetralogy of Fallot in which there is every reason to believe that the shunt is large) the inhalation of oxygen raised the arterial saturation not at all or to a less degree than in our patient. This simple experiment suggests that in this particular patient with congenital heart disease, an important degree of the cyanosis was due not to shunt, but to a pulmonary disorder. The nature of the pulmonary disorder interests us next. A photograph of the cut surface of the lung shows the extraordinary degree to which the vascular system of the lung was dilated. The larger vessels, both arteries and veins, showed well marked arterio-sclerotic change. The capillaries appear dilated but the alveolar walls are not demonstrably thickened. In the absence of such an explanation of the arterial unsaturation in pulmonary tissue changes we must look further. Hayek (10) has described the occurrence of what he believes to be arteriovenous anastomosis in the human lung. It is obvious that such anastomoses, if sufficiently numerous, would lead a significant amount of unoxygenated venous blood into the pulmonary veins. Cyanosis so produced, however, would not be affected by the inhalation of oxygen as long as the fistulae remained open.

May it be that the tremendous overfilling of all pulmonary vessels meant that the column of blood in the capillaries was sufficiently thick and the flow sufficiently rapid so that the blood did not come into equilibrium with the oxygen in the alveoli? At any rate this patient presents an instructive diagnostic problem and offers some suggestions about the mechanisms of cyanosis in congenital heart disease. She had *late* cyanosis which was not extreme; some of it was due to an alteration in pulmonary function and not to the admixture of venous and arterial blood. Some mechanism, probably a left-to-right shunt, led to a great dilatation of the pulmonary vessels, which may in some way have led to cyanosis. What this patient does is to serve as a take-off for further studies in the mechanism of cyanosis and in the circulatory mechanism of congenital heart disease.

The practical difficulties in the way of measuring the circulation in this and similar patients led us

to consider the production in animals of the lesions of congenital heart disease. As the beginning of what we hope may be the systemic study of a series of mechanical disorders, Dr. Gross and Dr. Eppinger have produced openings from 4 to 6 mm. in diameter in the interventricular septum of dogs and have studied their effects upon the circulation. These effects were measured mainly by the analysis of blood from various parts of the vascular circuit, including both ventricles.

In these animals the oxygen content of blood in the right ventricle is higher than that of blood from the right auricle, and it is evident that arterial blood is flowing through the abnormal opening from the left to the right ventricle. As we shall see later on, when short circuits occur in the circulation the short-circuited blood fails to traverse part of the usual conduit; and in the presence of certain lesions the amount of blood pumped by the two ventricles may be quite different. But in a shunt directly between the two ventricles, there is no difference in their output since all of the blood put out by the right ventricle goes to the left ventricle and is its only source of blood. Equally obviously all the blood put out by the left ventricle goes to the right ventricle, partly through the aorta and partly through the defect in the septum. However, since some of the blood from the left ventricle goes to the right ventricle, rather than out through the aorta, more blood passes through the lungs than passes through the peripheral circulation. In this situation, therefore, the *peripheral circulation* is by-passed by the shunted blood, but the ventricle is not by-passed. If the circulation to the periphery is to be maintained it is necessary for the output of each ventricle to be greater in the presence of a septal defect than when it is absent. That this was the case in the animals is shown by the figures presented.

Perhaps it would be interesting to try to relate these measurements to the manifestations of a defect of the interventricular septum as seen in patients. This may be done as follows:

1. A systolic murmur like that which is present in interventricular septal defect would appear to be incident in these dogs to the passage of some 1.5 liters of blood per minute by way of a 4 to 6 mm. opening connecting a high pressure area in the left ventricle to a relatively low pressure entry into the right ventricle. This murmur does not occur during diastole when the pressure in the two ventricles is similar.

2. The fact that the output of both ventricles is increased by this shunt appears to account for the increase in the size of the heart shadow which was observed in the dogs and which is often seen in patients.

3. An absence of ventricular preponderance in the electrocardiogram is common in both patients (Schnitker (11)) and dogs with this disorder and is perhaps associated with the point already referred to—that the work of both ventricles is increased and that the relation between the work of the two is not greatly altered.

When the opening is between the *auricles* and blood flows (as it apparently does) from left to right auricle the short circuited blood does not pass through the left ventricle at all. Therefore, the output of the right ventricle is greater than that of the left. In the light of this fact it is interesting that in this disorder there occur (Bedford, Papp and Parkinson (12)):

(1) Enlargement of the *right auricle and ventricle.*
(2) *Right ventricular* preponderance in the electrocardiogram.
(3) *Right sided* failure, if any.

According to Hope (4), the hypertrophy has been attributed by Bertin and Bouillaud to the introduction of a certain amount of red arterialized blood into the right cavities. Arterial blood they think calculated to occasion hypertrophy, in consequence of its being "more irritating, more nutritive, and possessed of more vitality than the venous blood." "I doubt," writes Hope, "whether this ingenious hypothesis is tenable, as the most remarkable cases of hypertrophy of the right ventricle have been those in which there was an extreme contraction of the pulmonary orifice, when consequently the current must have been so decidedly from the right to the left side, that no arterial blood could possibly have entered the right ventricle."

4. Returning to the interventricular defect, one wonders if there is a possible relationship between the fact that the work of the two ventricles is balanced, although increased, and the late onset of failure in these patients. It is true that we are most apt to see early failure in patients who have a mechanical burden which is preponderant on one ventricle or the other. You will recall that Dr. Levine (13) has shown figures suggesting that moderate hypertension has a favorable effect upon the duration of life in patients with mitral stenosis.

5. These patients are not cyanotic nor is their

arterial saturation reduced. This would appear to be adequately explained by the absence of right to left shunt and by a relatively moderate change in the circulation through the lungs.

These are two examples of fragmentary study. They might have been much further along for my presentation to you had it not been that the events of last autumn have naturally and properly led the group concerned with them to turn their efforts in quite different directions. Nevertheless these two fragments may yet be parts of a more comprehensive description of congenital heart disease. At the present stage they are interesting and provocative, but far from satisfactory. A better example of utility and instruction is to be found in the exploration into the problems of patent ductus arteriosus.

A patent ductus arteriosus is a functioning vascular connection between the pulmonary artery and the aorta. There is evidence in animal experiment that in the fetus blood flows through this channel from pulmonary artery to aorta, thus bypassing the not yet aerated lungs. Kennedy (14) has recently shown that when the lungs after birth are inflated with air or other gas mixtures rich in oxygen the ductus normally closes. In a few babies this adjustment to extrauterine conditions fails to come about and the child is left with a vascular structure which under the new conditions is not only useless but may be a handicap. Our first real exploration of congenital heart disease was an attempt to describe the circulatory adjustments to this curious anomaly. The observations were made by Dr. Gross, Dr. Eppinger and myself (15) in the patients operated upon by Dr. Gross. The operation, among other advantages, makes it possible to be quite sure that a patent ductus arteriosus was present in each patient studied by us.

There are two reasons to believe that in uncomplicated cases of patent ductus arteriosus the flow of blood (after breathing begins) is not in the direction it was in the foetus but from aorta to pulmonary artery. The first reason is that aortic pressure is higher than pulmonary artery pressure; the second is that *these patients are not cyanotic*, as they would be if a considerable volume of venous blood were entering the arterial circulation. Measurements of the oxygen saturation of the arterial blood in three patients known (from operation) to have had uncomplicated patent ductus arteriosus, gave the following figures: 95 per cent, 94 per cent and 94 per cent.

In these observations (which are quite like those in normal people) there is no suggestion of any new admixture of venous blood.

On the contrary, it can be shown that arterial blood from the aorta enters the pulmonary artery via the ductus arteriosus. The evidence is as follows: there is more oxygen in the blood in the pulmonary artery than in the blood coming from the right ventricle. (See Table I.)

This is the first direct demonstration of the direction of the flow of blood through a patent ductus arteriosus. It conforms thoroughly to expectation.

One asks at once, are there any circumstances under which the flow in these patients will be from pulmonary artery to aorta. The obvious answer is that such flow will occur when the pressure in the pulmonary artery exceeds that in the aorta.

TABLE I

Oxygen Content of the Blood in Patients with Patent Ductus Arteriosus

Femoral Artery	Pulmonary Artery	Right Ventricle
cc./l.	*cc./l*	*cc./l*
177	169	144
173	156	121
158	146	136
175	164	149

We have not made satisfactory measurements of the pulmonary blood pressure in these patients but Dr. Eppinger and Dr. Gross have carried out some experiments in dogs that bear on the problem and these experiments may be described briefly. A situation similar to patent ductus arteriosus was established by anastomosing the subclavian artery to the pulmonary artery. When this was done blood poured from the aorta by way of the subclavian into the pulmonary artery. The results of this anastomosis on the aortic and pulmonary pressures are shown in Table II.

The small extent of the change in pulmonary blood pressure is presumably due to the low resistance in the pulmonary blood vessels, as pointed out by Levy and Blalock (16) in discussing their somewhat similar experiments. The resistance in the lungs may rise because of back pressure from a failing left ventricle or because of chronic pulmonary or pulmonary vascular disease, but the pulmonary pressure has a long way to go before

it can surpass the aortic pressure and so lead to cyanosis from reversed flow. These reflections agree with the collective experience as summarized by Abbott and Weiss (17) to the effect that when cyanosis appears in these patients it is usually associated with the dyspnea of heart failure or is *terminal.*

The ingenious dog experiments by Eppinger and Gross taught us much more than these relative pressures. They were prompted by the necessity of answering questions raised by the study of our first patient. She was a child of six who presented the evidences of patent ductus arteriosus, was limited in her activity and was physically underdeveloped. Operation for ligation was carried out successfully. During the operation (and before ligation) blood was taken from the pulmonary artery opposite the entrance of the ductus. When this sample was analysed it was found that the oxygen content of blood taken from the pulmonary artery (with the ductus open) approached that of femoral artery blood so closely that the question arose as to whether the sample actually represented the blood which was entering the lungs. It was considered that this pulmonary artery sample might have been taken from the stream of arterial blood entering by way of the ductus before it was thoroughly mixed with blood from the right ventricle.

TABLE II

Pulmonary Artery Pressure Before and After the Establishment of a Communication between Aorta and Pulmonary Artery

Dog Number	Time	Aortic Pressure	Pulmonary Artery Pressure
		mm. Hg	*mm. Hg*
17-39	Before operation	116	16
	After operation		27
	5 weeks later		22
55-39	Before operation	124	16
	After operation	112	17
63-39	Before operation		16
	After operation		24
	8 weeks later	150	19

The first dog experiments were undertaken for the primary purpose of studying the point at which mixture of the convergent streams became sufficiently complete for a sample to be accepted as representative. In the first dog the oxygen content of a sample of blood taken from the pulmonary artery near the pulmonary valves was 150 cc. per liter, while that of a sample taken immediately opposite the entrance of the stream from the transplanted subclavian artery was 171 cc. per liter. However, samples taken from the left and right branches of the pulmonary artery several centimeters distant to the bifurcation gave values which were essentially identical—166 cc. per liter. This agreement in oxygen content of the blood going to the two lungs would appear to indicate that at these points mixture had occurred. Accordingly, samples from patients to be used in the calculation of pulmonary blood flows in patients with patent ductus arteriosus were subsequently taken from the pulmonary artery or its branches at a point as far as possible distal to the entrance of the ductus. Other points of technique were also studied: such as the validity of the method we used to obtain mixed venous blood of the patients when the ductus was open, and the changes which occurred in the occasional cases where the ductus entered the left branch of the pulmonary artery instead of the main artery.

With the guidance of these experiments we then proceeded to the measurement of the blood flow in these dogs and in patients. In people with no abnormal connection between peripheral and pulmonary circuits, the volume of blood passing through the lungs is essentially the volume of blood put out by the right ventricle, and this in turn is necessarily the same as the volume put out by the left ventricle. Neither of these statements is necessarily true in a patient with a patent ductus. The flow through an uncomplicated patent ductus arteriosus is, as has been shown, from aorta to pulmonary artery and therefore blood from the left ventricle may pass by way of the ductus and the pulmonary vessels back to the left ventricle *without having passed through the right.* Under these circumstances, the output per minute of the left ventricle is greater than that of the right.

When a patent ductus arteriosus permits the passage of blood from the aorta to pulmonary artery, the output of the right ventricle is made up of blood which comes to this ventricle from the peripheral circulation and from no other source. The volumes of the peripheral flow and the output of the right ventricle are then identical and this volume can be calculated if the oxygen consumption per minute, the oxygen content of blood in

the aorta and the oxygen content of blood in the right ventricle are known.

However, the output of the left ventricle in patients with an aortic-pulmonary leak is made up of two components: blood from the right ventricle and blood from the aorta entering the pulmonary artery by way of the ductus. The confluent streams pass through the lungs and to the left side of the heart. Since the blood entering the lung capillaries is only partly blood from the right ventricle the oxygen content of the right ventricle blood cannot be used in calculating the pulmonary blood flow. This calculation requires knowledge of the oxygen content of blood taken from the *pulmonary arterial system at a point where mixture of the two streams has occurred.* The operations by Gross presented an opportunity to obtain directly from the pulmonary artery and other vessels the crucial samples of blood that permitted these calculations.

The animal experiments, as has been said, enable us to test certain problems of technique. They also gave us certain results which it will be of interest to compare with those in patients.

A characteristic result of the production of an aortic-pulmonary connection in dogs is as follows: before the abnormal communication between the aorta and the pulmonary artery was established, the blood flow per minute through the lungs and also through the periphery was 2 liters. After an artificial patent ductus had thus been produced, the pulmonary circulation rose to 2.8 liters and the peripheral blood flow fell to 1.4 liters. The actual volume of the blood leaking from the aorta into the pulmonary circulation was, therefore, *1.4 liters per minute, or half of the output of the left ventricle.* The output of the left ventricle, therefore, was twice that of the right ventricle. In another animal the leakage or shunt was 75 per cent of the output of the left ventricle and the left ventricle was putting out four times the output of the right. In some animals the left ventricle output was not greatly increased, but the flow of blood to the periphery was diminished. In others the output of the left ventricle increased to such an extent that the volume put out by the right was less severely reduced.

Now it is the observation of patients that interests us most, because we are concerned with the recognition and the management of disease. During operation, samples were collected from appropriate vessels in patients and the results of the analysis of these samples were used in the calculation of the blood flow through the periphery and through the lungs of these individuals. It is important to have constantly in mind, while considering the results of these calculations, that the patients were not basal at the time these samples were obtained. They were obtained during anaesthesia when the chest was opened and there is evidence with which I need not detain you that they were much above the basal level. Therefore, these cardiac outputs cannot be compared with basal outputs in normal people or with other measurements of the circulation made in our patients under basal conditions. Let me present as an example the figures in one individual—a young woman, 26 years of age, and rather limited in mental capacity. She had always had dyspnea and easy fatigue, and had respiratory discomfort when

TABLE III

Patient M. S.

	Date	Pulmonary Blood Flow	Peripheral Blood Flow	Volume of Shunt	Percentage of Shunt
		l/min.	*l/min.*	*l/min.*	
Ductus Arteriosus Patent	Dec. 22, 1939	14.1	6.0	8.1	57
Ductus Arteriosus Ligated	Dec. 22, 1939	6.3	6.3		

she lay flat. Her heart was enlarged to the left. There was a systolic murmur at the apex and a continuous murmur in the second left interspace, accompanied by a thrill. The pulmonary second sound was accentuated. The arterial blood pressure was 128/66.

A diagnosis of patent ductus arteriosus was made. She was operated upon on December 22, 1939, under ether anaesthesia. The ductus measured 8 mm. in diameter and was closed by ligation. During the operation samples were obtained which permitted the calculations set forth in Table III. Thus our results in these patients not only permit us to investigate the direction of flow, but also to calculate its volume. This patient, under the conditions of operation, had a *pulmonary* blood flow which exhibited the extraordinary magnitude of 14 liters, at a time when the blood flow through her *periphery* was 6 liters. This meant that during this time some 57 per cent of the blood put out by

the left ventricle was leaking out of the arterial system by way of the ductus back into the lungs. When the ductus was closed by ligation, the blood flow through the lungs and through the periphery became identical at about 6 liters. These figures seem extreme, but Keys (18) has recently applied the acetylene method to the study of a sizable group of patients with patent ductus arteriosus, first bringing evidence that this method is acceptable. He concludes also that the leak may be from 20 to 70 per cent of the left ventricular output. The peripheral flow was below the normal range in only four of twelve patients. These measurements were made in patients carefully standardized and "basal."

It has been shown in these patients that the lungs and consequently the left ventricle have two sources of blood and that the right ventricle only has one, that is, the periphery, and that, therefore, there is a difference in the output of the two ventricles. These inequalities in their outputs must affect the work done by the two ventricles. In all the patients studied the left ventricle was putting out (at the time of the observation) over twice the volume of blood expelled by the right. The work of the right ventricle is probably not greatly changed. It is true, as we have shown, that the pulmonary artery pressure may be elevated to some degree in the presence of a patent ductus, and one may speculate that this elevation may advance with advancing age.

The increase in the output of the left ventricle implies an increase in work unless there is a corresponding diminution in the mean arterial pressure. It is true that the mean pressure is somewhat lower than normal in these patients, but it is not sufficiently depressed to prevent a considerable increase in the work of the ventricle. Lack of data with regard to other factors, such as the velocity factor, make it difficult to make precise calculations of the work of the ventricles, but I think that one can conclude that the work of the left ventricle is increased, and this suggestion is borne out by the fact that when heart failure occurs in patients with patent ductus it usually is predominantly left sided, and by the fact that the x-ray film commonly shows a dilatation or hypertrophy of the left ventricle. It is perhaps surprising that preponderance of the left ventricle is not more common in the electrocardiograph tracings than it is shown to be by the observations of Schnitker or those of ourselves. Perhaps one may compare the response of the left ventricle to the demand for increased work in these cases with the response which occurs in patients with arteriovenous fistula—that is, mainly a reversible dilatation and only rather late a true hypertrophy.

Obviously (that word again) the diversion of a considerable volume of blood per minute from the aorta to the pulmonary artery may result in: (1) a diminution in blood supply to the periphery; (2) an increase in the output of the left ventricle; (3) a combination of the two. Actually, in every patient and in every dog in which studies were made there was an increase in the output of the left ventricle. Sometimes this was sufficient to maintain the peripheral flow at or near the normal level. In other patients, this compensation was not complete and in these patients the peripheral flow increased when the ductus was ligated. If this means that there was a diminution in peripheral blood supply, it may be related to the observation of Gross (19) that ligation of the ductus may be followed by accelerated growth and improved nutrition in children. These gains suggest that abolition of the shunt permits a larger amount of blood to be distributed to the periphery.

A leakage of so much blood from the aortic system may be expected to produce changes in the peripheral pressure. Such changes occur and the blood pressure is often useful in deciding as to the presence or magnitude of the shunt. The characteristic change is an increase in the pulse pressure brought about mainly by the fall of the diastolic level. In patients with a large ductus the low diastolic pressure may fall still lower following exercise such as stair climbing. In normals, the usual change after exercise to this degree is different. Patients with a small ductus may exhibit no fall.

Such striking alteration in flow and pressures in the chambers of the heart and in the adjacent great vessels may lead to certain changes in the x-ray signs. As one would postulate from the measurements which have been reported, the most obviously occurring phenomena are (1) enlargement and increased pulsation of the left ventricle; (2) prominence and increased excursion of the pulmonary artery; (3) congestion of the pulmonary vascular system; and (4) enlargement of the left auricle. These x-ray signs were sought for in the light of the circulatory measurements. And they were found in a large proportion of the people we

studied, each of whom we knew to have a large patent ductus.

Many other studies have been made. The peripheral venous pressure has been found to be normal. The pulmonary circulation time is shorter after operation than before. There is some evidence both in patients and in animals that a large aortic pulmonary leak leads to an increase in the total blood volume. There is still some question as to whether this increase is directly associated with the leak or is the result of the development of true congestive heart failure.

In general, the circulatory measurements that have been made in patients emphasize the extent of the changes in the demands made upon the heart. They support the point that ligation of the ductus may be indicated for the purpose of relieving the heart of an eventually disabling burden. They explain quite clearly the benefits of operation in patients with failure or diminished reserve, and they have enabled us not only to explain the well-known diagnostic signs and symptoms, but also to look for and to find certain others, particularly those associated with the x-ray. Such descriptions of disease in terms of altered functions are as useful in understanding the disease and its manifestations as descriptions in terms of morphology, and they are quite as apt to be associated with an understanding of the problems of therapy. Completeness of description thus leads to better diagnosis, better treatment, and is still an indispensable part of the advance of medicine.

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Scientific Accomplishments of the United States Army Medical Corps*

Part II

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Scientific Accomplishments of the United States Army Medical Corps

By EDGAR ERSKINE HUME

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PART II

VENTILATION AND STUDY OF THE EFFECTS OF OVERCROWDING

IN HIS pioneer work on the *Treatment of Wounds and Fractures*, Surgeon John Jones (1729–1791) gave medical officers sage advice on the effects of overcrowding soldiers. Those were the days, it will be remembered, in which fresh air was hardly considered worth mentioning.

Jones showed that overcrowding had been the main cause of the great mortality in London and Paris hospitals. Jail fever, or as we would now say, typhus fever, was directly traceable to this practice, as was also dysentery, said he. Though he never heard of living microörganisms as the cause of disease, Jones was doubtless right in his observation. He recalled also a number of European campaigns in which the sick and wounded were crowded together in one general hospital, with resulting high mortality. On the other hand, he observed that the sick and wounded left in camp, though naturally subjected to many discomforts, nevertheless generally recovered. He therefore advised medical officers to treat their patients in camp where possible, and when this could not be done to make use of churches, barns and outhouses, open to the rafters, without any ceiling. Private houses and other places into which sick and wounded men could be crowded were to be avoided. Jones's advice was not always followed, but the Continental Army suffered each time it was neglected.

At this time Surgeon James Tilton (1745–1822) of Delaware was in charge of the general military hospital at Trenton, New Jersey, and he too concluded that overcrowding was a serious menace to patients. He therefore did away with hospital tents and private houses then in use and had a series of log huts constructed, roughly built, so that air could circulate freely through the crevices. Most important of all he allowed not more than four or five men to each hut. These rude structures had many of the virtues of modern cubicles and successfully prevented direct infection from man to man. This was explained to the soldiers who seemed to understand and did not object to the cold nor to the floorless, hard (sometimes baked), soil underfoot. The fireplace was the center of the hut, a hole being left at the ridge so that smoke could escape. Tilton announced with pride that his plan (1780) had proved successful and that typhus fever had greatly diminished. The same resulted wherever this system was put into operation throughout the Continental Army. Obviously typhus-bearing lice cannot spread so well when men are not closely crowded together.

Tilton also noted what we now call cross infections, particularly in pneumonia.

Tilton is justly entitled to credit for his having for the first time shown the ill effects of overcrowding. Too bad that his doctrines were not always followed in later campaigns. But it may be said that whenever overcrowding has been permitted a high price has been paid for the neglect of what Jones and Tilton realized in America's first war. Among those convinced by Tilton's experiences was Benjamin Rush (1745–1813) who in 1777 was Surgeon-General of Hospitals, Middle Department, later becoming Physician-General of the same. Rush in his *Directions for Preserving the Health of Soldiers*, published in 1777, stressed the dangers of overcrowding.

Though the term was not known in Billings's day, he might well have been called a ventilating engineer. He made the most noteworthy contributions to this subject for the period in which he was active. His treatise *Ventilation and Heating* (1884) is an index of his intensely practical cast of mind when applied to a theme of immediate and special importance. The work was first written as a series of engaging *Letters to a Young Architect* (1879), and published in the *Sanitary Engineer*. Billings's treatment of a somewhat dry subject was characterized by his humor and the whole is interesting reading even now. A second edition (1893) was considerably enlarged and a fine chapter on the

history of the subject included. The style of the work may be seen from the concluding paragraph:

"The most wasteful of all expenditures for a public building is to provide an elaborate and costly apparatus for heating and ventilating, and then intrust it to the care of an ignorant and careless engineer, selected not on account of his knowledge of what is to be done and how to do it, but because he is 'somebody's nephew,' or is an 'active politician', or is 'unable to support his family'."

Of particular interest in any consideration of ventilation is Billings's chapter on that subject in his elaborate plans for the Johns Hopkins Hospital. But he wrote many other reports and papers on the subject. Some of them are: *Patents on Ventilating Apparatus* (1880), *On Ventilating the House of Representatives* (1882), *Ventilating a School Building* (1882), *Principles of Ventilation and Heating* (1884), *Ventilation and Heating* (1894). These are all different aspects of the problem, though the titles are unfortunately much alike. Billings was regularly consulted in problems of ventilating the Capitol in Washington.

THE WAR ON MALARIA

Malaria has always been a disease of the greatest interest to medical officers of all armies, and certainly the greatest advances in our knowledge of the malady have been made by men of that profession. In 1880 Charles-Louis-Alphonse Laveran (1845–1922), a medical officer of the French Army, discovered the parasite of malaria while serving with the French Army in Algeria. In the following year he described the parasites in all their aspects. His four great treatises on paludism are classics. In fairness, however, one must add that Laveran's discovery was largely unknown until brought before the medical profession in 1886 by Surgeon Sternberg, U.S.A. (Osler). In 1897 Sir Ronald Ross (1857–1932) of the Indian Medical Service, then a major, demonstrated the anopheles mosquito as the vector of malaria. He discovered the Laveran plasmodia in the stomach wall of the anopheles which had fed on the blood of malarial patients. He proved that one stage of the parasite is found in the salivary glands of the insect. He likewise devised methods for the destruction of mosquitoes which he put into effect with success in Sierra Leone, Lagos, the Gold Coast, and Ismailia. Both Laveran and Ross were awarded the Nobel Prize and other high recognition of their work.

But it was the Americans who gave the greatest demonstration of antimalarial work. From 1898 onward our troops were instructed to use mosquito nets and otherwise taught how to avoid exposure. Ours was the first Army to employ this measure, a recommendation, of course, of the Medical Department. The work of Gorgas and his associates in Havana was directed mainly to the prevention of mosquito breeding. During the same period when yellow fever was being abolished in the Cuban capital, the malarial incidence was reduced seventy-five per cent. Later the same administrator obtained the same results in Panama, as described elsewhere.

The use of the mosquito bar as an anti-malarial measure and not merely as an aid to comfort, was first recommended by Major (now Brigadier-General, retired) Jefferson Randolph Kean in 1898. Kean was then Chief Surgeon of the Department of Havana. His recommendation was put into effect in 1900 by a circular published from Headquarters, Department of Western Cuba.

Malaria, as we all know, is not as easily eradicated as yellow fever because *Anopheles* is not a domestic insect, as is *Aëdes*, and the malarial patient, instead of being capable of giving the infection to the mosquito for three days only, as is the sufferer from yellow fever, is dangerous for weeks, months, or even years. Malaria patients are also far more numerous than yellow fever patients.

A medical officer of the Army who has done much in malariology is Colonel Charles Franklin Craig, who demonstrated the intracorpuscular conjugation of malarial plasmodia as the cause of latency and relapses, and of the existence of carriers.

But the work goes on, and witness the results thus far: In 1901 the incidence of malaria in the U. S. Army was 381 per 1000; in 1902 it was 272; in 1907, 85; in 1926, 8; and in 1927, 6. The reduction continued past that year, even though it was the period of the floods in the Mississippi Valley with consequent malarial increase among the general population. The rate has gradually gone down. It was 5 in 1940. Of course it is too soon to know the effect the Second World War, with its tropical service, will have on the Army's malaria rate.

The country's malarial rate has of course declined of late years, but the rate in the Army much more sharply than that for the general population. One hundred years ago malarial fevers were responsible for more than 25 per cent of all admis-

sions from disease to Army hospitals. Since the World War they have been responsible for only 1 per cent.

During the World War there were only 15,555 cases of malaria among American troops, with 36 deaths. Fifty per cent of the cases had less than two months service, and 67 less than four. One hundred and ninety-three men, or less than an infantry company, were constantly incapacitated on account of it. Had the same conditions and the same rates prevailed as during the Civil and Spanish-American War, 38,000 men, or more than a full division—and those were the days of the large or "square" divisions—would have been incapacitated for military duties each day during the World War period from 1 April 1917 through 31 December 1919. And during October, 1918, when there was the greatest military need for men, more than three full-size divisions would have been so incapacitated.[18]

The methods used by the Army in bringing about this satisfactory reduction included drainage, oiling of all standing water, screening of all quarters and hospitals, prevention of access of mosquitoes to patients with malarial infections, thorough treatment of all malarial patients during both acute and chronic stages, careful and enforced use of mosquito nets for troops in the field or where barrack screening is defective. Civic improvement too has helped, with the bringing of waste areas under cultivation.

Even in our present emergency Army medical officers have added to our knowledge of mosquito vectors of malaria. In the West Indies, officers under the direction of Lieutenant-Colonel Leon Alexander Fox, Medical Corps, found that the disease is also transmitted by *Anopheles bellator*, a mosquito not theretofore incriminated, and which breeds in various plants growing on trees and which hold accessible water. This discovery, made in 1941, is the Army's latest blow in the malarial war. The Bailey K. Ashford Medal, named for Colonel Ashford of the Medical Corps (see chapter on Hookworm), was in 1941 awarded by the American Society of Tropical Medicine to Dr. Lloyd Eugene Rozeboom of Johns Hopkins for this discovery.

Our medical officers are keenly awake to the danger of the spread of malaria by means of airplane transportation of infected mosquitoes. Already such experience has been had in South America. It is one of aviation medicine's great problems in preventive medicine.

[18] Cf. Love, *The Military Surgeon*, July, 1926, 92.

AMERICA'S OLDEST SCHOOL OF PREVENTIVE MEDICINE:

THE ARMY MEDICAL SCHOOL

It is a matter of pride to the Medical Department of the Army that the oldest American medical school was established by two medical officers of the Army, men who were successively its Surgeon Generals, to give them the modern title. The medical school is that of the University of Pennsylvania, created in 1765 by two graduates of the University of Edinburgh. John Morgan (1735–1789) was Director General and Physician-in-Chief of the American Hospital from 1775 to 1777, being succeeded by William Shippen, Jr. (1736–1808), Director General of the Military Hospitals of the Continental Army, 1777 to 1781. These two medical officers became enemies in later years engaging in one of the most famous medical controversies in the country's history, one in which Benjamin Rush played a part. This is not the place to consider this topic. Both officers suffered from the effect thereof, but both must be given great credit for their pioneer spirit in establishing a great medical school. Physician-General Benjamin Rush (1745–1813), signer of the Declaration of Independence, succeeded Morgan as Professor of the Practice of Medicine and must likewise be considered one of the founders of the University of Pennsylvania.

Army medical officers have played an important part in medical education throughout the country's history. Space precludes even a partial list of them, though it would include Sternberg the bacteriologist, Billings the bibliographer (who was Professor of Hygiene at the University of Pennsylvania), Hammond the anatomist, Strong the tropical physician, Russell the professor of preventive medicine, and many, many more.

The Medical Department has the oldest of what are termed "special service schools" in the Army. This is the Army Medical School, which Dr. William Henry Welch called "America's oldest school of preventive medicine." This school was first projected by Surgeon General William Alexander Hammond (1828–1900) during the War Between the States. The plan had gone so far that the professors had been selected, the scope of the course fixed and the lecture rooms and laboratories made ready. Then the whole scheme fell through

when the Secretary of War withheld his sanction. This office-bearer was the Honorable Edwin McMasters Stanton (1814–1868), now best remembered for his disloyalty to President Lincoln. He was Hammond's bitter enemy and finally had him tried by court martial and dismissed from the service. Many years later Hammond was exonerated and restored to his rank. But the Army Medical School of Hammond's day died aborning.

The Army Medical School was finally created by a great man of science, Surgeon General George Miller Sternberg (1838–1915). He had the project in mind before he took office and in less than three months, on his recommendation, the War Department issued General Order No. 31, 24 June 1893, founding the school. Its work has gone on continuously without cease and by means of its researches as well as teaching, it has taken a goodly part in public health advances of the country.

Though the Medical Field Service School of the Army at Carlisle Barracks, Pennsylvania, is not primarily concerned with teaching preventive medicine, it does add considerably to the sum of knowledge of this subject. One of the departments of the school is that of Military Sanitation, the instruction being both theoretical and practical. From this department have come three important texts, *Military Preventive Medicine* by Major (now Brigadier-General) George Clark Dunham (1930, second edition 1931, third edition 1938). The second, prepared under the direction of Major (now Brigadier-General) Morrison Clay Stayer is *Essentials of Field Sanitation* (1933), revised 1935 and 1940. The third, *Elements of Military Hygiene* (1937) was prepared under the direction of Lieutenant-Colonel (now Colonel) George Fairless Lull, and while designed for a text for the United States Military Academy, West Point, is also used by several other military academies. It is now being revised.

It was the members of the Tropical Research Board, particularly First Lieutenant Richard Pearson Strong and Dr. William Everett Musgrave, Hospital Steward, who built up the excellent Bureau of Science, Manila, and later the Medical School that is now the Medical Department of the University of the Philippines. Lieutenant Strong later resigned from the Regular Army and has had a brilliant and outstanding career as one of America's leading authorities in tropical medicine. He was, until his retirement, Professor of Tropical Medicine at Harvard and head of the Harvard School of Tropical Medicine.

STUDIES OF DIETS AND NUTRITION

Somewhat related to Beaumont's work on the physiology of digestion may be mentioned several studies of nutrition and the effect of special diets.

One of the Army's greatest Surgeon Generals was undoubtedly William Alexander Hammond (1828–1900) of Maryland. He first conceived of an Army Medical School; created the Army Medical Museum; devised a system of hospital reports and statistics that is really not yet out of use, though often modified; founded the first permanent military hospital in Washington; recommended the creation of the Hospital Corps (forerunner of our present medical soldiers); formed the first military medical laboratory; and worked out an efficient system of the transportation of medical supplies. For these and other things the Army honors him. He likewise merits much respect from the medical profession as a whole.

The medical study upon which his international reputation was first built was *The Nutritive Value and Physiological Effects of Albumin, Starch and Gum, when Singly and Exclusively used as Foods.* The American Medical Association awarded him its medal for this study in 1857. Later, when he resigned from the Army the reputation thus gained had much to do with his being appointed to the chair of Anatomy at the University of Maryland.

Hammond's other contributions to science are elsewhere mentioned, as well as his tragic military career, court martial and subsequent exoneration.

Surgeon General Robert Maitland O'Reilly (1845–1912) induced Professor Russell Henry Chittenden of Yale to undertake important experiments in the *Physiological Economy of Nutrition.* The practical objective was to ascertain the best ration for troops under modern conditions. Chittenden used a squad of Hospital Corps men of the Army. His work was published in 1905 and has been most valuable in modern studies of nutrition.

With the acquisition of new territory and new responsibilities at the close of the Spanish-American War the Medical Department of the Army had many new problems to solve. In the Philippines, for instance, they saw beri-beri for the first time. Our newly created Philippine Scouts and Philippine Constabulary, with their native personnel, were seriously handicapped by it. It had already been studied by British, French and Dutch physicians in the Far East. The Japanese had freed their navy from it by changing the ration of the men.

In 1909 the Board for the Study of Tropical Diseases, then consisting of Captains James Matthew Phalen (now Colonel, retired) and Henry James Nichols (1877–1927), recommended the substitution of unmilled for the previously used highly milled rice, as well as a slight reduction in the amount of rice in the diet and a substitution of beans to make up the difference. Prohibition of savings on fresh beef, onions and potatoes was likewise recommended. Beri-beri underwent a sharp decrease. The Tropical Board continued its studies.

Captain Edward Bright Vedder (now Colonel, retired) gave the greater part of his time to this study for many years. His prolonged and excellent work, and his monograph on the subject, won him the Cartwright Prize in 1913.

The aftermath of Vedder's study of beri-beri among Philippine Scouts is interesting. In 1909 there were 604 scouts admitted to hospital with this disease. In 1910 the number was 50. It was but 2 in 1911. Since 1911 there have been no cases at all. These gratifying results have been since attained by civilians, except that the actual zero has not yet been attained.

Today the Army Medical Department maintains at the Army Medical Center, Washington, one of the country's leading schools for dietitians. Commissions for women dietitians, comparable to those of the nurses, are being considered by Congress.

During the present World War the matter of consideration of food and nutrition is being studied by the Medical Department. The Surgeon General issued on 21 February 1942, Circular Letter No. 15, setting forth the duties of Food and Nutrition Officers, "who are concerned primarily with the nutritional welfare of enlisted men." These officers have been directed to study the diets of soldiers, recommend changes as necessary, advise commanding officers and mess officers and others. They are to coöperate with medical inspectors, the Quartermaster Corps, and others concerned with the soldier's food.

TYPHUS FEVER FOUGHT IN SERBIA AND POLAND

Typhus fever is the age-old scourge of armies in the field in cold weather. It is the evil companion of privation and suffering. Down through the ages comes the tale of its ravages. Not even the fear of war itself is greater than the terror inspired by this malady, probably the Black Death of the Middle Ages and later. Men flee from it, without knowing where to go. Panic may result from families becoming separated and victims left to die unattended and alone. I have myself seen these things.

Medical officers of the United States Army have conducted two extensive campaigns against typhus fever, one in Serbia and other Balkan countries, the other in Poland. Both campaigns were considered successful. There were two entirely separate campaigns in Serbia during the first World War and the period immediately following. The first commission was created in 1915 by the American Red Cross, which bore the expenses. The personnel were selected by Surgeon General William Crawford Gorgas, but he did not wish any Army medical officer to take part because of the neutrality of the United States. It is interesting, however, to note that the director selected by General Gorgas was a former medical officer of the Regular Army, Colonel Richard Pearson Strong of Harvard. Many of the other members of this commission later served as medical officers in the Great War, for instance Colonel Hans Zinsser (1878–1940), also of Harvard (then of Columbia), whose fascinating account of his experiences may be read in his autobiographic works. Zinsser and Strong both won the Distinguished Service Medal for their war work.

The work of the commission of 1915 came to an end with the invasion of Serbia by the Germans and Bulgarians. Thereafter nothing further was done to aid the Serbs until after the Armistice of 1918. Then typhus fever having once more become a serious menace, another American Red Cross Commission was sent to Serbia. The personnel were largely drawn from the Army, though there were some officers of the Naval Medical Corps as well. These officers were discharged from the military service before joining the Red Cross, with the exception of the Commissioner, who was an officer of the Medical Corps of the Regular Army. I pay tribute here to the splendid work of my associates in this campaign. The problem to be solved in 1919–1920 was quite different from that of 1915, because of entirely new factors depending on the political situation, the return of countless former prisoners of war, the creation of new governments and the like. Of course there was no difference as to the mode of attacking the problem. For instance every student of sanitation knows the "Serbian Barrel" developed for practical steam sterilization of clothing. The campaign was successful and the Americans brought succor to a

land which had lost nearly eighty per cent of its medical practitioners in the wars and epidemics of typhus fever.

Equally important was the campaign against typhus in Poland. It was directed by Major-General Harry Lorenzo Gilchrist, then Colonel, Medical Corps, and later Chief of the Chemical Warfare Service of the Army. The personnel of this commission were drawn directly from the United States Army and were still in that service while engaged in their work in Poland. Poland was in the pangs of rebirth and the invasion by Russia further complicated the problem. The typhus fever campaign in Poland was successful though not without casualties on the American side. One officer, Lieutenant-Colonel Edward Chauncey Register, Jr. (1884–1920), was awarded the Distinguished Service Medal posthumously by the War Department, having perished of typhus in Poland. In Serbia too a number of American officers, nurses and men contracted the disease, and some of them died.

Today the service has what it did not have during the first World War, a prophylaxis against typhus fever. Now all of our Army personnel are given this immunizing treatment.

ORNITHOLOGY STUDIED BY MEDICAL OFFICERS

To those not familiar with the scientific studies and contributions of Army medical officers it may seem surprising to know that some of the country's greatest ornithologists have been officers of the Medical Corps of the Regular Army.

It began in the decade preceding the War Between the States. The West was then the scene of the Army's work. A vast empire was being built and the United States Government had only its small Army with which to protect the settlers and property. Hostile Indians were everywhere, and often even more hostile white outlaws. Life for an Army officer was busy and exciting. But there were lulls in every campaign, comparatively brief periods during which a man of earnest, industrious mind could do valuable things aside from the profession of arms. No group was able to do more, and actually did more than medical officers. They were usually the best educated men in the Army and developed resourcefulness and initiative of a high order. It was such men who, in so many instances, made ornithology something more than a hobby, and collected and described specimens hitherto unknown. They often knew how to write of their work in graphic and accurate form.

Professor Spencer Fullerton Baird (1823–1887), Secretary of the Smithsonian Institution, induced the War Department to permit selected Army surgeons serving in the West to perform the additional duties of naturalists in the several surveys of railway routes and for other purposes. These young men were inspired by Baird's genius and winning personality. Some of the work done by them is unsurpassed in the country's ornithological history.

There has recently been issued by the Institute of the History of Medicine of the Johns Hopkins University a monograph of some 600 pages: *Ornithologists of the United States Army Medical Corps*, with foreword by Dr. Alexander Wetmore, in charge of the United States National Museum and a distinguished ornithologist. In writing this book I gave long study to the work of the thirty-six medical officers of our service who have done important ornithological investigation. In its preparation I was surprised to realize that the more important of the group were known to medical officers as excellent military surgeons, without the additional knowledge that they had been ornithologists as well. Similarly, I found that zoölogists of today were familiar with the work of these men as ornithologists but that they were officers of the Army Medical Department was frequently overlooked. One of the purposes of the book was to give each group the full picture.

The most distinguished ornithologist of the Army Medical Corps is Surgeon Elliott Coues (1842–1899) of New Hampshire. He wrote an important monograph on the *Tringeæ of North America* when he was but nineteen. Entering the Army as Assistant Surgeon in 1863, he was ordered West in the closing months of the War Between the States. There he threw his whole free time into ornithological study. A constant stream of specimens was forwarded to the Smithsonian Institution and his publications were many and of the greatest importance. His stations were changed from time to time, as is the way in the Army, and each new one brought opportunities for new achievement. While serving at Fort McHenry, Maryland, he prepared for publication one of the most important ornithological works ever written, *Key to North American Birds*, which appeared in October 1872. It went through six editions, the last appearing after Coues's death.

Of it Allen of the National Academy of Sciences said: "It has had above all others the most important influence on ornithology in our own land. It is a work that in its conception and masterly manner in which it is carried out in all its details, stands as one of the best, if not *the* best bird book ever written." It is on this great reference text that Coues's fame rests chiefly.

Other important ornithological works by Coues are: *Birds of the Northwest* (1874), *Birds of the Colorado Valley* (1878). Coues also wrote on mammals and on exploration, his studies of the expeditions of Zebulon Pike (of Pike's Peak), of Lewis and Clark, of Jacob Fowler, and of Francisco Garcés, are all standard works. He wrote, moreover, on many other topics, for instance theosophy. From 1884 to 1891 Coues was one of the collaborators in the preparation of the *Century Dictionary*, having charge of the departments of Zoölogy, Biology and Comparative Anatomy. He furnished over 40,000 definitions and hundreds of illustrations.

He resigned from the service in the grade of Major and devoted thereafter his full time to ornithology, being closely associated with the Smithsonian Institution. He was elected a member of the National Academy of Sciences at the age of thirty-four, being its youngest member.

Other ornithologists who served in the West and whose work was done largely in the 'Fifties include: Surgeon William Wallace Anderson (1824–1911) of South Carolina, who not only collected and described birds, but made excellent drawings. He also made copper engravings by hand, impressions from one of them being the frontispiece of my recent study. Acting Assistant Surgeon James Graham Cooper (1830–1902) of New York did magnificent work in California, where the *Cooper Ornithological Club*, an active organization today, bears his name. He entered the military service in 1853 and was one of Baird's surgeon-naturalists. His *Ornithology of California* (1870) is called by Baird, Brewer and Ridgway "the most valuable contribution to the biographies of North American birds that has appeared since the time of Audubon." Assistant Surgeon and later Major-General Samuel Wylie Crawford (1827–1892) of Pennsylvania was another of Baird's collaborators in the West and his lifelong friend. Crawford was the medical officer at Fort Sumter, South Carolina, at the time of the memorable siege that opened the War Between the States. Acting Assistant Surgeon Samuel Moore Finley (1841–1885) of Pennsylvania (son of Surgeon General Finley) contributed material from Texas that Professor Baird considered valuable. Surgeon Andrew Jackson Foard (1829–1868) of Georgia, who served, as did Anderson, both in the United States and Confederate States Armies, was another of Baird's representatives in the West. Foard became General Joseph Eggleston Johnston's chief medical officer and won that commander's praise for his work on the battlefield and in organization. Colonel John Fox Hammond (1820–1886) of South Carolina, who served in the Union Army in the War Between the States, made extensive contributions to Baird's rapidly growing collections in the Smithsonian Institution and was a prolific correspondent with the professor. The future Surgeon General William Alexander Hammond (1828–1900) of Maryland was also one of Baird's coworkers before the War of 1861. Surgeon and Brevet Colonel Thomas Charlton Henry (1825–1877), another South Carolinian who served in the Union Army, was especially distinguished as an ornithologist. His publications were many and the number of new specimens sent by him to Professor Baird is very great. Acting Assistant Surgeon Adolphus Lewis Heermann (1827–1865), son of Surgeon Lewis Heermann, U. S. Navy, is one of the most important of American ornithologists, his work too having been done before the War Between the States. His writings, chiefly in the *Proceedings of the Academy of Natural Sciences of Philadelphia*, are numerous and important. Several birds have been named in his honor, as was the case with some of the other ornithologists of this group. Brigadier-General Bernard John Dowling Irwin (1830–1917) is another medical officer who aided Baird. He had one of the most interesting careers of any of his contemporaries on the Plains. He was awarded the Congressional Medal of Honor for extreme gallantry in the Indian campaigns. He is famous too as having introduced the use of tent hospitals in time of war, as elsewhere described. Acting Assistant Surgeon Caleb Burwell Rowan Kennerly (1829–1861) of Virginia was still another of Baird's surgeon-naturalists. His recently found diary throws light on his valuable career, cut short when he was drowned at sea. His publications, too, were issued by the Philadelphia Academy of Natural Sciences. Brevet Colonel William

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OF PHILADELPHIA

Shakespeare King (1810–1895) of Pennsylvania and Brevet Lieutenant-Colonel DeWitt Clinton Peters (1829–1876) of New York, likewise aided Baird with their ornithological field work in the period just before the War of 1861. The same is true of Surgeon Richard Potts (1828–1866) of Maryland, who served later in the Confederate Army. Brevet Colonel George Suckley (1830–1869) of New York, was a collaborator of Cooper. Much of their work was published under both names. Brigadier-General Ebenezer Swift (1819–1885) of Massachusetts, Colonel Edward Perry Vollum (1827–1902) of New York, Brigadier-General Timothy Erastus Wilcox (1840–1932) of New York, and Acting Assistant Surgeon Samuel Washington Woodhouse (1821–1904) of Philadelphia, were all Baird's associates and helpers. Woodhouse is a most distinguished figure whose publications may be regarded as basic. Another medico-military ornithologist of this period was the brilliant and eccentric Hungarian, John Xántus, who did splendid work in the West and was made an Acting Assistant Surgeon by Surgeon General Hammond, with whom he had worked. He held no medical degree, but was a Hospital Steward for a time. Another Hospital Steward (a grade corresponding to Sergeant today) was Charles Emil Bendire (1836–1897), who later became an officer of the line. His ornithological contributions were extensive, the most important being *Life Histories of North American Birds* (1892), of which Dr. Knowlton of the Smithsonian Institution said: "These magnificent volumes will remain as a monument to Bendire and a high mark for the emulation of future workers." Bendire was Honorary Curator of the Department of Oölogy in the U. S. National Museum.

Besides the officers listed above there isanother group which have worked in the modern period, that is, since the turn of the century. Best known of them is Lieutenant-Colonel Edgar Alexander Mearns (1856–1916) of New York, who made the first ornithological studies in the Philippines after American occupation. He accompanied President Roosevelt to Africa on his expedition, collecting specimens for the National Museum, and was also in Africa as naturalist to the Frick Expedition. He was a prolific writer, but much of his material has yet to be published, being deposited in the Division of Birds in the National Museum. Colonel Basil Hicks Dutcher (1871–1922) of New York, was another early ornithological student in the Philippines as well as in the United States. Major-General Leonard Wood (1860–1927) and Brigadier-General James Denver Glennan (1862–1927), though better known, of course, for other work, were likewise contributors to our knowledge of ornithology. Brigadier-General Edward Lyman Munson (1868–) of Connecticut made pioneer studies of the speed of ducks in flight. Acting Assistant Surgeon Daniel Webster Prentiss (1834–1899), well known Washington physician, was Coues's collaborator in a monograph on the birds of the District of Columbia. Acting Assistant Surgeon (later Lieutenant-Colonel, Medical Reserve) Henry Crècy Yarrow (1840–1929) of Philadelphia was a prolific writer on ornithology and collector of material in the field. He was naturalist to the Wheeler Expedition, i.e., the Geographical and Geological Exploration and Survey West of the One Hundredth Meridian, and published (1874) an extensive report on his work. Of the younger men, Lieutenant-Colonel Leon Lloyd Gardner (1894–), who is now on duty in the Surgeon General's Office, wrote a valuable report on the tongues of birds, published by the Smithsonian Institution in 1925.

THE ARMY INTRODUCES PHOTOMICROGRAPHY

When the Army Medical Museum was established Assistant Surgeon Joseph Janvier Woodward (1833–1884) of Philadelphia, was assigned as assistant to the Curator, Surgeon John Hill Brinton (1832–1907). He devoted himself at first to the preparation of the medical volumes of the history of the late war, but his old interest in microscopy and photography, which had begun while he was a student in Philadelphia, again manifested itself. He began to experiment in a thorough way with photomicrography, and was first to apply it to the study of pathology. In this he attained an international reputation. The results of his first experiments were published in his *On Photomicrography with the Highest Powers as Practiced in the Army Medical Museum* (*American Journal of Science and Arts*, September, 1866). He was instrumental in improving the photomicrographic camera and its lighting.

Woodward's apparatus is still to be seen in the Army Medical Museum. He worked for years on photomicrography, the results of his labors appearing in a series of articles in various journals. The *Index Catalogue* lists fifteen of them, *inter alia: Report on the Magnesium and Electric Lights as*

Applied to Photo-micrography (1870), *Report on the Oxy-Calcium Light as Applied to Photo-micrography* (1870), *Report to the Surgeon General on an Improved Method of Photographing Histological Preparations by Sunlight* (1871), *Photomicrographs of Certain Parasites* (1872), *The Application of Photography to Micrometry with Special Reference to Blood in Criminal Cases* (1876), *Photo-micrographs of Blood Corpuscles of Man, Dog, etc.* (1876), *Miscellaneous Photomicrographs: International Exhibition* (Centennial, Philadelphia 1876).

Woodward wrote *The Hospital Steward's Manual* (1862), a work that has been extensively used and republished in several revisions by others. He also wrote on the general history of the Army Medical Museum. He was a member of the National Academy of Sciences and was the first Army Medical officer to be President of the American Medical Association. He attended President Garfield throughout his last days and in 1881 wrote *Official Record of the Post-mortem Examination of the Body of Pres. James A. Garfield.* Billings, in an obituary, paid glowing tribute to Woodward—a convincing bit of evidence of Woodward's greatness.

Woodward's faithful collaborator in much of his work at the Army Medical Museum on photomicrography was Assistant Surgeon and Brevet Major Edward Curtis (1838–1912). Curtis in 1869 worked with Billings in investigating the supposed microörganisms causing diseases of cattle.

Another Army medical officer who did work in photomicrography was Major Robert Wilson Shufeldt (1850–1934), who wrote *Improved Apparatus for Making Photomicrographs of Parasites of Birds.*[19] Shufeldt was an ornithologist and was most successful in his photographs of birds in the wild state.

No account of the development of photomicrography in this country could be complete without reference to Surgeon General Sternberg's remarkable photographs of bacteria and other microörganisms. Sternberg used some of these pictures to illustrate his writings, having been, as elsewhere shown, the author of the first American textbook on bacteriology. The excellent enlargements of some of Sternberg's photomicrographs, particularly those of the pneumococcus which he first described, are still to be seen in the Army Medical Museum. They are on display in the large museum hall, and even with the most modern technique and apparatus better pictures are not made. Among them is the first photograph ever made of the tubercle bacillus. He used sunlight only, not depending on anything resembling modern electric lighting apparatus.

There is no more complete installation for photomicrography, including pictures in colors, than that of the Army Medical Museum at present and its personnel are highly skilled in such work.

AVIATION MEDICINE

It is now common knowledge that in the great majority of accidents in aviation, the fault lies with the pilot and not with the aeroplane or other craft. Therefore anything that can be done to ensure better performance by pilots is a valuable advance in knowledge. The Medical Corps of the Army has done this.

In January, 1918, the Medical Department established the Central Medical Research Laboratory at Mineola, Long Island, our first center for the study of the medical side of flying. From this laboratory grew the School of Aviation Medicine, now at Randolph Field, near San Antonio, Texas.

This school trains the flight surgeons of the United States Army and many of those of the Navy as well. It likewise trains numerous examiners who function under the Department of Commerce, Division of Aviation. One of the directors of the School of Aviation Medicine was Colonel Louis Hopewell Bauer, who resigned in 1926, and became the Medical Director of the Division of Civil Aeronautics, Department of Commerce.

Aviation medicine is progressing rapidly, and it is still the Medical Department of the Army that takes the lead.

PERIODIC PHYSICAL EXAMINATIONS FIRST GIVEN BY THE ARMY

Today every popular magazine contains advertisements from insurance companies and others urging all and sundry to consult their physicians from time to time and to be on the lookout for certain early signs of disease. Nobody would now think of doubting the wisdom of such practices. The Medical Department of the Army claims priority in putting periodic physical examinations into effect.

[19] *Auk*, 1894, xi.

After much had been said and written on the subject, President Theodore Roosevelt, acting upon the recommendation of Surgeon General Robert Maitland O'Reilly (1845–1912), issued an order in December, 1907, requiring annual physical examination of all officers of the Army. The Medical Department has conducted these examinations annually ever since that date. Besides such examinations officers must be carefully examined upon promotion, upon orders requiring overseas duty and on certain other special occasions. Of course, this is in addition to physical examinations on admission to the service which are required of all personnel. More recently optional annual physical examinations for dependents (women and children) of Army personnel have been introduced, and good results are already apparent. The examinations of flyers are considered elsewhere.

HOSPITAL CONSTRUCTION

When the Johns Hopkins Hospital was opened in Baltimore in 1891 in the presence of a distinguished audience, it was called the most modern institution of its kind in the world. This opinion was confirmed by the medical profession of this and other countries. It is not only a great hospital in itself, it has served as a model for others in many places. Its arrangements have been copied in all quarters of the world.

The designer of such a hospital, therefore, must be rated as a great man. That man was the protean John Shaw Billings. The story of Billings's connection with the Johns Hopkins Hospital was told at length last year when the institution reached its half-century mark. The Trustees, appointed under the will of Mr. Johns Hopkins, asked five experts to submit plans for the projected hospital. One of these experts was Stephen Smith, father of the American Public Health Association and other bodies. Another was John Shaw Billings, whose plans were considered best by the Trustees and were accepted. The plans of the architect proper were adapted to Billings's plans and ideas. Billings was also asked by the Trustees to go to Europe and carry out a suggestion he had himself made, i.e., to visit various hospitals and so derive further information of value. With the Surgeon General's approval Billings was permitted to give much of his time to the general work of supervising the construction of the new hospital. Its Superintendent, Dr. Henry Mills Hurd (1843–1927), remarked in 1913 at the memorial meeting held at the time of Billing's death, that the institution was built much upon the lines of an army hospital.

Of particular interest was Billings's detailed study of the problem of ventilation, which is considered in the chapter upon that subject.

Billings supervised the planning and administration of two other important hospitals, the Barnes Hospital of Washington (at the Soldiers' Home) (1873), named for Surgeon General Joseph K. Barnes (1817–1883) of Pennsylvania, and the Peter Bent Brigham Hospital in Boston (1905). For this last he was engaged by the corporation of the new Boston institution in 1905. It was completed in 1913, the year of Billings's death. Billings, be it said in this connection, directed the planning and building of four other important structures: the Army Medical Library and Museum, the New York Public Library, the Laboratory of Hygiene at the University of Pennsylvania, and the William Pepper Laboratory of Clinical Medicine of Philadelphia.

Though the Medical Department of the Army has built many a large and modern hospital since the time of Billings, it can hardly claim great credit for priority in new ideas and plans. However, one other type of hospital, developed by the Army, must be mentioned in this connection. This is the *tent hospital* designed for the care of a large number of patients in an emergency. The first use of a tent hospital in war was by an American Army medical officer, that fine old soldier and holder of the Congressional Medal of Honor, Brigadier-General Bernard John Dowling Irwin (1830–1917).

In the brilliant campaign recently conducted in the Philippine Islands by General MacArthur and his successor, the Medical Department, for the first time in three-quarters of a century, established open air hospitals.

TUBERCULOSIS CONTROL

The officers of the Medical Department of the Army have made several important contributions to the sum of our knowledge of this disease.

It was General Sternberg who first photographed the tubercle bacillus. His negative is still in the Army Medical Museum and the photograph is an excellent example of his skill as a photomicrographer. Sternberg also established

the Army's first hospital for the treatment of tuberculosis, at Fort Bayard, New Mexico.

In January 1913 Colonel George Ensign Bushnell (1853–1934) summed up his studies on susceptibility to tuberculosis in a paper *Immunity Through Tuberculosis Infection* in *The Military Surgeon* (1913, **32**, 29–51). The article was prepared at the request of Surgeon General George Henry Torney. In it the author stressed the doctrine that he had enunciated and which he was trying to bring home to the medical profession. In his own words:

"If we have succeeded in our attempt to prove that all or nearly all civilized adults have come in contact with tuberculous bacilli and have thereby been vaccinated against a recurrence of tuberculous infection from without, it is obvious that the facts brought forward will have an important bearing upon practical sanitation in the army. . . . When several cases develop under the same conditions in adults, the contemporary occurrence of the disease, if not purely a coincidence, is usually due to the exposure of the patients to identical unsanitary or otherwise depressing influences. Pulmonary tuberculosis is slow in development and cases of presumed recent infection upon analysis are generally found to be of long standing. The development of chronic localized pulmonary tuberculosis as the result of recent infection is certainly an impossibility. . . .

"There is therefore no excuse so far as adults are concerned for the phthisiphobia so extensively preached nowadays by popular writers. There is no need of indecent and cruel haste in isolating, and worse in sending away to a sanitarium the detected consumptive. The prevention of tuberculosis in the army depends upon the maintenance of good hygiene of the individual and of his surroundings, this quite independent of course of the presence of a source of tuberculous infection. But there is always a possibility which must be admitted that a few individuals are unprotected against tuberculosis or more probably have but an improper immunization against the infection. Just as the fact that soldiers have been successfully vaccinated does not warrant the abandonment of disinfection for small pox, so the fact that soldiers are probably immune to reinfection with tuberculosis does not justify us in relinquishing attempts at disinfection for that disease. In either case we are considering the welfare of the minority who may not be completely protected, and as regards tuberculosis it is doubtless of advantage to destroy all tuberculous infection wherever found and thus do what we can to avoid the massive infection of the unprotected, especially young children. No pains are too great to secure complete disinfection of quarters in which a patient with 'open' tuberculosis has lived if they may become at a later time the abode of the families of officers and enlisted men. As an obvious corollary it is perhaps unnecessary to say that the presence of tuberculin-sensitiveness is no proof that an existing affection is manifest tuberculosis."

These ideas were set forth in detail, being, in effect, a statement of the "endogenous theory" as to the etiology of the disease. Though Bushnell's concepts are not now accepted at full value, he did make a valuable addition to the sum of our ideas as to the cause of tuberculosis. He may be credited with a changed attitude towards the individual patient, who had begun to be considered somewhat as an untouchable.

The more modern view of the epidemiology of tuberculosis, to which the army has made contributions, is that infection is the result of exposure. The longer the exposure, the greater the chance of infection. This is the "exogenous theory." Young people between 5 and 14 are almost wholly immune to tuberculosis, but in the years immediately following the incidence rate is highest. Those years are, of course, the military age.

In 1924 Lieutenant-Colonel (now Major-General, retired) Harry Lorenzo Gilchrist showed at a Congressional hearing that the incidence of tuberculosis is not increased among men who have previously been exposed to warfare gases. His findings were based on his study of the American Army's World War experience (Warfare Gas and Tuberculosis, *The Military Surgeon*, April, 1924, liv, 470–485). The study was later enlarged and published by the Chief of the Chemical Warfare Service (1928).

One of the leaders in the fight against tuberculosis in this country is a former Surgeon General of the Army, Major-General Charles Ransom Reynolds. At his retirement he was appointed (1939) to organize the Bureau of Tuberculosis Control of the Commonwealth of Pennsylvania, a position that he still holds. The field of activity of this bureau includes surveys, at present confined to state teachers' colleges, Negro groups, and contacts of known cases of tuberculosis. General Reynolds remembered that during the World War the

tuberculosis rate among Negro soldiers was about three and one-half times as great as among white soldiers. Hence he felt the need of the present type of surveys. The General has charge of 88 tuberculosis clinics throughout the State. In 1940 thirty-one pneumothorax centers were established, where treatment is available for ex-sanitorium patients. Beginning in March 1940 provisions were made for the x-ray examination of all clinic patients at State expense. By this means, and the surveys, efforts are made to find early or minimal cases which are most amenable to treatment.

With the beginning of Selective Service physical examinations at the outset of the present emergency, the Bureau of Tuberculosis Control has placed under treatment men rejected because of tuberculosis. More than 250,000 records have been studied and thus far an epidemiological survey of nearly 5000 men and their immediate contacts has been made. Treatment and hospitalization has been instituted where required.

Not only is this work directed by General Reynolds; another retired Army medical officer is his chief assistant. He is Colonel William Hadley Richardson, who has supervision of the State tuberculosis sanitaria.

FIRST AMERICAN TEXTBOOK ON SURGERY

An American military surgeon, Surgeon John Jones (1729–1791) of Massachusetts, wrote the first American textbook on surgery. It was published in 1775 at a time when our medical officers were badly in need of such a work, for almost no books on medicine were available.

The title of the book is: "Plain Concise Practical Remarks on the Treatment of Wounds and Fractures; to which is added, a Short Appendix on Camp and Military Hospitals; Principally Designed for the Use of young Military Surgeons in North-America." It was printed in New York in 1775, in Philadelphia in 1776, the latter edition being 114 pages in length.

Dr. John Jones, the author, who had been a surgeon of French troops during the French and Indian War (1758), entered the American military service as Surgeon's Mate of the Tenth Massachusetts Regiment, Continental Line on 1 September 1777 and was promoted Surgeon on 24 September 1777, and served as such until 14 May 1781. The book was written, therefore, before he received his commission, and while he was Professor of Surgery at King's College, New York, the present Columbia University.

Jones's monograph was "an excellent little book" says Brown in his history (1873) of the Medical Department, U. S. Army, and was useful not only in laying down the accepted principles of surgery but also in giving some wise council on military hygiene. Some of Jones's conclusions are mentioned under Ventilation. This was the first American work on military medicine.

SURGERY OF GUNSHOT WOUNDS

It was Hippocrates himself who said: "He who would become a surgeon should join the army and follow it." If this were true in the days of spear, sword, battleaxe and arrow, it became all the more obvious after the introduction of firearms. This is not the place to consider the opportunities for the study of anatomy by military surgeons when dissection was still forbidden, but they played a great part in the advance of military surgery as a specialty.

The United States Army's surgeons have had their share of field experience with wounds caused by firearms, as well as more primitive weapons, and some of them have left valuable studies of their work.

Assistant Surgeon John Hill Brinton (1832–1907) was demonstrator of operative surgery at the Jefferson Medical College before the Civil War. After field experience with surgery of gunshot wounds during that war, he was made Curator of the Army Medical Museum and devoted his interests to surgical pathology. He wrote the article on *Gunshot Wounds* in the *Medical and Surgical History of the War of the Rebellion.* In 1865 he resigned his commission and returned to the faculty of the Jefferson Medical College, where in 1882 he succeeded the great Samuel David Gross (1805–1884) as Professor of the Practice of Surgery and Clinical Surgery. He became professor emeritus in 1906. He edited Sir John Erich Erichsen's (1819–1896) *Science and Art of Surgery* (1854). In 1869 he delivered the Mütter Lecture before the College of Physicians of Philadelphia on surgical pathology, his subject being *Gun-shot Injuries.*

Growing also out of the War Between the States were the valuable studies of gunshot and other injuries of the nerves made under the orders of Surgeon General Hammond by three distinguished Acting Assistant Surgeons: Silas Weir Mitchell

(1830–1914), George Read Morehouse (1829–1905), and William Williams Keen (1837–1932). Their work, *Gunshot Wounds and Other Injuries of Nerves*, published first in 1864, is regarded as a classic. It was expanded into *Injuries of Nerves and Their Consequences* (1872). It is mentioned here because it was a definite military medical contribution, even though the authors were not career officers.

The great John Shaw Billings (1838–1913) is hardly remembered as a surgeon, this phase of his work being overshadowed by his preëminence as a bibliographer. Yet he was the first surgeon in America successfully to perform the rare operation of excision of the ankle joint (6 January 1862), with complete recovery of the patient.

One of America's greatest specialists in gunshot wounds, not only as to their treatment, but likewise considering their pathology, was Brevet Lieutenant-Colonel and Surgeon George Alexander Otis (1830–1881). He was well known as a surgeon in the period just before the outbreak of the War Between the States. A native of Massachusetts and M.D. of the University of Pennsylvania, he went to Paris for advanced work in 1851. In that year the rioting that marked the *coup d'état* of Louis-Napoleon gave him the opportunity to see actual military surgery and to follow such masters as Velpeau, Roux, and Jobert. In 1852 he returned to America and made his home in Richmond, Virginia.

There he established the *Virginia Medical and Surgical Journal*, and made it an excellent periodical, notable for its translations and abstracts from the French. In 1854 he removed to Springfield, Massachusetts, where he practiced medicine until the outbreak of the War Between the States. He was appointed Surgeon of the 27th Massachusetts Volunteers and served with that regiment in the field in Maryland, Virginia and North Carolina. While on detached duty in 1863 in the Department of the South he came under the notice of Surgeon (later Surgeon General) Charles Henry Crane (1825–1883), and the good impression he made resulted later in his being given the special duty in Washington whereon he built his reputation. Otis resigned from the Massachusetts regiment in 1864 and became an Assistant Surgeon, United States Volunteers. In 1866 he received appointment as Assistant Surgeon in the Regular Army.

In June 1864 he was assigned to duty in Washington, where the Surgeon General made him assistant to Assistant Surgeon Brinton, then Curator of the Army Medical Museum. Later he succeeded Brinton as Curator. In 1866 Otis, with Joseph Janvier Woodward (1833–1884), was given the huge task of preparing the *Medical and Surgical History of the War of the Rebellion*. Otis wrote the surgical volumes. The first of them appeared in 1870 and included consideration of special wounds and injuries of the head, face, neck, spine, and chest. It is a richly illustrated volume and includes interesting discussions of the subject.

The second volume was published in 1876, and treated of the wounds and injuries of the abdomen, pelvis, back, and upper extremities. Both volumes met with an immediate enthusiastic reception. At the time of his death, at the age of fifty-one, he was engaged in preparation of the third volume, which was completed under the editorship of Colonel David Low Huntington (1834–1899).

While preparing the surgical volumes of the great history, as well as before, Otis wrote several important monographs on gunshot wounds and other military surgical conditions. They were published from the Surgeon General's Office as "Circulars," a most inadequate term. They are: *Report on Amputations at the Hipjoint in Military Surgery* (1867), *Report on Excisions of the Head of the Femur for Gunshot Injury* (1869), *Report of Surgical Cases Treated in the Army of the United States from 1865 to 1871* (1871), *Report on A Plan for Transporting Wounded Soldiers by Railway in Time of War* (1875), *Report on the Transport of Sick and Wounded by Pack Animals* (1877).

Of the moderns none has done so much as Colonel Louis Anatole La Garde (1849–1920). His interest began when he was serving on the Western plains against the Indians, who had already learned to use the rifle in preference to the bow. While on duty at Fort McHenry, La Garde published a preliminary report on septic bullets. He showed for the first time that the act of firing does not, as had previously been thought, sterilize a projectile, and that sepsis can be carried into wounds when specially applied to missiles.[20] In 1893 the U. S. Army adopted the new Krag-Jorgensen military rifle and La Garde undertook, upon order of the Secretary of War, experiments on cadavers to determine the proper metal envelope for the new bullet. The steel jacketed bullet, still in use, was the result of his work. In 1893

[20] *N. Y. Med. J.*, 1892.

La Garde published *The Gunshot Injuries by the Mantle Projectiles* in *The Military Surgeon.* In the years following he wrote frequently for that journal, his more important papers being: *Septic Bullets and Septic Powders* (1894); *Experiments Illustrating the Degrees of Powder Burns as Modified by the Distance of the Object, Size and Conformation of the Bore, Amount and Standard of the Powder, and Other Practicable Demonstrable Cases* (1895); *Remote Effects of Gunshot Wounds by Jacketed Projectiles* (1900); *Effects of the Luger and Colt's Automatic Pistols* (1902); *Bacterial Flora of Infected Gunshot Wounds* (1916).

His experience in the Spanish-American War was set forth in *Effects of the Mauser Bullet in the Santiago Campaign,* in *the Proceedings of the District of Columbia Medical Society,* 1899. Thereafter he presented papers on gunshot wounds before medical societies in all parts of the country, his articles being published in the *Johns Hopkins Hospital Bulletin,* 1900; *N. Y. State Journal of Medicine,* 1902; *Journal of the American Medical Association,* 1903, etc. In August, 1900 he read an account of his work before the Thirteenth International Congress of Medicine and Surgery in Paris. Besides his article on *Gunshot Wounds* in the *Reference Handbook of the Medical Sciences* (1902) his best known publication is his monograph: *Gunshot Injuries* (1914; second edition, 1916). In 1902 La Garde delivered The Mütter Lecture before the College of Physicians of Philadelphia, on *Poisoned Wounds by the Implements of Warfare.* This was thirty-seven years after Brinton's Mütter lecture on gunshot wounds. In 1941 the Army named La Garde General Hospital of New Orleans in honor of this distinguished son of Louisiana.

Other important contributions by medical officers of the U. S. Army to the study of gunshot wounds, also in *The Military Surgeon* are: *Wounds Made by Large and Small Bullets: A Digest of the Past Experience Compared to Experiments Recently Made on the Effects of Small-Calibre Infantry Arm,* by Major Alfred C. Girard (1893); *Remote Effects of Gunshot Wounds of the Extremities,* by Lieut.-Col. C. M. Woodward (1894); *The Latest Experiments on the Effect of Small Calibre Rifles,* by Major Alfred C. Girard (1894); *Some Considerations Concerning the Location and Detection of Missiles,* by Major Surgeon Roswell Park (1895); *Experiments with the New* [*Krag-Jorgensen*] *Army Rifle—Protection of the Soldier,* by Brig. Gen. Jefferson D. Griffith (1895); *Some Effects of Bullets,* by Brig. Gen. Jefferson D. Griffith (1897); *The Laws of Physics and Ballistics; the True Explanation of the Lodgement and Deflection of the Majority of Modern Small-Arm Projectiles, not the Ricochet Hypothesis,* by Major Charles B. Nancrede (1903); *Gunshot Wounds in Military Surgery,* by Maj. Frederick M. Hartsock (1912); *Dispersion of Bullet Energy in Wound Effects,* by Col. Louis B. Wilson (1921); *Gunshot Wounds of the Face and Jaws, First Aid Treatment, Field Service,* by Lieut. Col. Roy A. Stout (1940); *Traumatic Wounds of the Soft Tissues of the Face, with Preliminary Report on a New Azochloramide Solution, and a New Modified Sulphanilamide Solution,* by Capt. Francis F. Kintz (1941).

The story of the Army's surgical work in the World War, including, of course, much on gunshot wounds, is compiled in two large volumes of *The Medical Department of the United States Army in the World War:* Volume XI, Part 1 (1324 pages), and Part 2 (327 pages). These lengthy reports consider General Surgery, Orthopedic Surgery, Neurosurgery, Empyema, Maxillofacial Surgery, Ophthalmology and Otolaryngology.

Even were gunshot-wound surgery confined to the armed forces, advances in this branch made by medical officers of the United States Army would entitle them to the gratitude of their brother practitioners. But gunshot wounds have a way of occurring in civil life all too frequently, so that they are by no means of interest only to the military surgeon.

Gunshot wounds of the face and jaws are of interest to both the medical and dental professions. Following the first World War the great problem of cosmetic facial surgery was met largely by the Dental Corps. Colonel Robert Henry Ivy of Philadelphia, an officer of the Reserve, gave much of his time to this work at the Walter Reed General Hospital, Washington, where excellent results were obtained. One has only to inspect the photographs and models displayed at the Army Medical Museum to realize the outstanding success of the Army's work in restoring human likenesses to men mutilated in war.

More recently, surgery of the jaws and face has been skilfully done by Lieutenant-Colonel Roy Albert Stout, Dental Corps, who has had charge of this work at the Walter Reed General Hospital.[21]

[21] Cf. his paper "Gunshot Wounds of the Face and Jaws. First Aid Treatment, Field Service," *The Military Surgeon,* Sept., 1940.

FORENSIC BALLISTICS

Medical officers of our Army have often given special attention to legal medicine in many of its aspects. Some of Col. La Garde's studies of the effect of projectiles on human beings had such a basis. More recently, an honor graduate of the Army Medical School, Lieutenant-Colonel Calvin Hooker Goddard, made extensive studies of the identification of projectiles. His work has been of the greatest value to law enforcement agencies, some of whom have overlooked giving credit where credit is due.

Goddard worked out for the first time accurate methods of comparing an "unknown," i.e., a fired bullet, with one fired experimentally from a suspect weapon. This is done by ascertaining, by means of twin comparison microscopes, whether the same markings are found on both bullets. If the markings, made by the rifling of the barrel, are the same, then it is certain that the "unknown" and the control bullet were fired from the same weapon. "Unknown" fired shells are identified in a similar manner. By means of this procedure a number of important medico-legal cases have been decided.

Goddard also undertook to compile statistics on rifling characteristics of all the types and varieties of guns that could be examined. Thus, in the absence of a suspect weapon, it is often possible to ascertain, from the study of rifling marks on a bullet, or the firing pin, breech-face and extraction marks on a shell, what make of weapon fired it. Again this has proved a valuable aid to the law.

Other studies made by Colonel Goddard concern improvements on methods of determining whether a weapon has recently been discharged, and if so, approximately how much time was elapsed since that event. He standardized a technique for testing a gun to determine whether it may have figured in a suicide, an accident, or a murder, provided it were known definitely that the gun under examination were the lethal weapon. This technique is based on ascertaining the distance of the muzzle from the wound of entry at the time the fatal shot was fired, which factor being known, it is often possible to differentiate between the three types of death (accident, suicide or murder).

Colonel Goddard has presented results of his studies in many journals, both those pertaining to ordnance and those concerned with military medicine. The following articles from a lengthy bibliography are quoted as illustrative of his work in an important and highly specialized field: *Forensic Ballistics*, *Army Ordnance*, 1925; *The Identification of Projectiles in Criminal Cases*, *The Military Surgeon*, 1926; *The Scientific Identification of Firearms*, *Journal of Criminal Law and Criminology* (Chicago), 1926; *Bullets as Evidence in Shooting Cases*, *New York State Medical Journal*, 1926; *Forensic Ballistics*, *Medical Times* (New York), 1929; *Scientific Crime Detection Laboratories in Europe*, *American Journal of Police Science*, 1930; *The Truth Serum*, *Hygeia* (Chicago), 1932 (reprinted in *The Readers Digest*); *How Science Solves Crime*, *Hygeia*, 1932.

So great was Colonel Goddard's interest in this field that he left the Medical Corps of the Army and established the Bureau of Forensic Ballistics in New York, 1925, later becoming head of the Scientific Crime Detection Laboratory of Northwestern University. He is now on active duty at the Army War College as an ordnance officer. His *Medico-Legal Significance of the Scientific Crime Detection Laboratory of Northwestern University* was published in *The Military Surgeon*, December, 1930.

The medical side of ballistics has also been studied by Colonel George Russell Callender, assisted by Staff Sergeant R. W. French. Their experiments were made at the Army Medical Museum, of which Colonel Callender was then Curator. Their work was particularly important in demonstrating the explosive effect of high velocity projectiles.[22] Colonel Callender has been assigned the duty of preparing the section on *Offensive Weapons in Relation to Injury* for the medical history of the present war.

THORACIC SURGERY

After the close of the first World War two classes of military patients remained long under treatment. The tuberculous, those seriously disabled or mutilated in war, and cases of empyema following pneumonia and influenza. The last group were, largely, sent to the Walter Reed General Hospital in Washington for treatment. The surgical treatment afforded them there was of the best. The chief of the Surgical Service, who was directly in charge of this work was Colonel William Lordan Keller, later in charge of the hospital where he spent many years of continuous duty. His results were excellent and brought him renown. When he reached retirement age he was accorded a reward that was without precedent in the history

[22] "Wound Ballistics," *The Military Surgeon*, 1935.

of his Corps. Congress continued him on full active duty pay for the rest of his life. He became consultant to the Walter Reed Hospital and still has this nominal assignment.

THE ARMY'S FIELD SURGERY

It is an accepted military concept to medical officers of today, that the surgeon is taken to the patient rather than the patient to the surgeon, wherever practicable. Of course the military situation must be given first consideration, as in all matters relating to military medicine.

Such was not always the case. In the early wars of the eighteenth century, and those which went before, surgeons did some field surgery, but it was much more likely that the wounded would be gathered, usually after the battle, and the surgeon visit them.

While it cannot be claimed that American military surgeons were first to attempt to take the surgeon to the patient, one of them, William Shippen, Jr., Director General of Military Hospitals of the Continental Army, did more or less effect this in a systematic way by his creation of "Flying Ambulances." The term "ambulance" was then used partly in the European sense, to connote what might now be called a field hospital. The word was also applied to the chariot-like vehicles used to transport the surgeon to the patient.

The system of caring for the wounded devised during the War Between the States by Jonathan Letterman (1824–1872), Medical Director of the Army of the Potomac, was in reality directed to this end.

With the background of the World War experience, the Medical Department in 1921 created the Medical Field Service School at Carlisle Barracks, Pennsylvania, the purpose of which is to teach such doctrines. Its motto "To Conserve Fighting Strength" expresses its purpose. In 1941 a Department of Field Medicine and Surgery was created at this school to study and develop new clinical methods for field service.

One cannot consider field surgery without mentioning the supervision of professional work done in the American Expeditionary Forces in France in 1917–1918. The chief consultant was Colonel William Lordan Keller, under whom several of the leading clinicians of the country had charge of the several specialties. The Chief Surgical Consultant was Colonel John Miller Turpin Finney, and the Chief Medical Consultant was Colonel William Sydney Thayer, both of Johns Hopkins and both later Brigadier-Generals in the Medical Reserve.

PLAGUE CONTROLLED IN MANILA

One of the diseases encountered by the Medical Department of the Army with the taking over of the administration of the Philippines was plague. The first important American studies of this disease were made by the Board for the Study of Tropical Diseases. Its members were First Lieutenant Richard Pearson Strong, First Lieutenant William Jophtha Calvert and acting Assistant Surgeon Joseph J. Curry, assisted by Dr. William Everett Musgrave (1869–1927), Hospital Steward.

The Circular issued by this board in February, 1901, is a landmark in the literature of plague. The transmission by the flea was not yet known and the Indian Plague Commission had not yet done its splendid work. However, plague was kept out of the Army and the disease controlled in epidemic form in Manila.

PNEUMONIA PREVENTION

It is but fitting that the United States Army Medical Department, one of whose Surgeon Generals, Sternberg, discovered the pneumococcus, should make valuable contributions to prevention of that dread "Captain of the Men of Death."

In his study of the epidemic of pneumonia among troops at El Paso, Texas during the period of our mobilization (1917) for the first World War, Colonel (then Major) Henry James Nichols (1877–1927) showed that the disease was principally due to Type I and Type II of the causative organism.

Nichols also called attention, possibly for the first time, to the fact that while military surgeons had concerned themselves during the present century chiefly with intestinal diseases, those due to infection through nose and throat discharges (sputum borne) were likewise of great importance. He stated what the whole profession was soon to know, that epidemic lobar pneumonia is to be expected in large camps during the winter months.[23] He once remarked: "Respiratory, not intestinal disease, will be the scandal of the World War."

The Army's practice in treating pneumonia is well illustrated in a report of eighteen years experience at the William Beaumont General Hospital at Denver, Colorado. This institution exists for the treatment of patients with tuberculosis and other pulmonary maladies. Writing in 1940,

[23] *The Military Surgeon*, August, 1917.

Colonel Thomas Ewing Scott and First Lieutenant Ernest Martin Nielsen summed up the hospital's experience:

Mortality was 11.77 per cent in 400 cases of acute lobar pneumonia. They felt that this showed that treatment at high altitude (4000 feet) was not less satisfactory than elsewhere. The rates have steadily declined with the newer modes of treatment, particularly the use of type-specific sera and sulfapyridine, in combination or separately.[24]

Since 1933 the Medical Department has been producing pneumonia vaccine at the Army Medical School and distributing it to various Government agencies for trial. The reports have been most encouraging. Pneumonia prevention by the use of the Felton serum, a polysaccharide derivative of the pneumococcus, containing a solvable substance, was begun in the Army in 1934. It was first tried in the First Corps Area (New England States) under the direction of the Corps Area Surgeon, Colonel George Macy Ekwurzel. Surgeon General Reynolds extended the work to include many areas of the Civilian Conservation Corps in 1935. In the inoculated groups, during the years 1933 to 1937, the case rate for lobar pneumonia was 79.5 per 100,000 enrollees in the Civilian Conservation Corps; during the same period the rate for the uninoculated (control) groups was 225.9. During the year 1938, 271,000 doses of pneumococcus vaccine were supplied to the agencies of the Civilian Conservation Corps. A large reserve stock of this vaccine was on hand when the National Emergency of 1939 arose.

During recent years atypical pneumonia in sporadic and epidemic form has been recognized in Hawaii, Panama, and in parts of the continental United States. *Army Medical Bulletin*, No. 61, April, 1942, included a description of the clinical and other features. The Surgeon General directed by Circular Letter No. 19, 2 March 1942, that such cases of pneumonia be reported separately from other types of the disease. Pathological tissue from these cases was ordered sent to the Army Medical Museum for study.

TRENCH FEVER IDENTIFIED IN FIRST WORLD WAR

During the first World War there was differentiated an acute communicable disease not unlike typhus fever in some of its manifestations, but not fatal, though prostrating for a time. The British Army gave it the name "trench fever" and much was written about it. The French, Italian, German and Austrian Armies also had this disease, which was found to be louse borne.

When the American Expeditionary Force went to France cases were reported also among American soldiers and a commission was appointed to study the problem. The American Red Cross established a Medical Research Committee to do this work, under the direction of a distinguished reserve medical officer, who had formerly held a commission in the Regular Army. This was Colonel Richard Pearson Strong, head of the Harvard School of Tropical Medicine. Trench fever was found to be due to an agent related to that causing typhus fever. The results of the Commission's work were published in a monograph issued by the American Red Cross.

THE FIRST AMERICAN PHARMACOPŒIA

Physician General William Brown (1748–1792) of the Middle Department of the Continental Army, the senior medical officer of Virginia, prepared the first American pharmacopœia, and it was extensively used during our Revolution. Brown was born in Haddingtonshire, Scotland, where his father, a native of Maryland, was studying for the ministry. Receiving his M.D. at the University of Edinburgh in 1770, he returned to Virginia in time to be commissioned Surgeon of the Second Virginia Regiment, Continental Line, 1775. After several promotions he became Physician General of the Middle Department in 1778 and in that year published his Pharmacopœia. The Pharmacopœia was published anonymously in 1778. A second edition appeared in 1781, and bore Brown's name. Both editions are rare, but are in the Army Medical Library.

MALTA FEVER FOUND ENDEMIC IN OUR SOUTHWEST

Malta fever has never been a serious problem in our Army, but several Army medical officers have contributed to our knowledge of it. It was first described in the Army by First Lieutenant Walter Cox, Medical Corps, in 1898. It was somewhat later studied in Manila by First Lieutenant Richard Pearson Strong and Dr. William Everett Musgrave (1869–1927), Hospital Steward. In 1911 Captains Ernest Robert Gentry and Thomas Ludlow Ferenbaugh, Medical Corps, now Colonels, showed that the disease is endemic in our South-

[24] *Ibid.*, March, 1940.

west. More recently Gentry has done good work on the closely related, if not identical, *Bacillus abortus* infection.

CHOLERA AND DYSENTERY REDUCED IN THE PHILIPPINES

Among the great plagues of our Army in all its wars before the first World War, the chief was, after malaria, dysentery. The general public too, particularly in tropical and subtropical areas, was severely affected. By 1900 Acting Assistant Surgeon (now Colonel, retired) Charles Franklin Craig was writing of amœbic dysentery as observed in the General Hospital at the Presidio of San Francisco (now Letterman General Hospital). In the Philippines Assistant Surgeon (later Colonel) Richard Pearson Strong and Dr. William Everett Musgrave (1869–1927), Hospital Steward, reported on both bacillary and amœbic dysentery. The extent of their observations and recommendations was comparable to that of the circular on Plague, above mentioned. In 1900 the Army's admission rate for dysentery was 145.13 per thousand; in 1901 it was 82.65; in 1902, 22.03; in 1907 it was 18.09; for 1926 it was only 0.02 for the whole Army and 0.24 for the Army in the Philippines. Since that time the rate has continued low.

In connection with consideration of amœbic dysentery, we must not forget that the Anglo-Indian practice of using ipecac in treatment, was introduced in the United States by Brigadier General Alfred Alexander Woodhull (1837–1921) of the Army Medical Department in 1875–1876. His paper is: *Clinical Studies with the Non-nauseating Dose of Ipecacuanha, Chiefly in Intermittents, Atlanta Medical and Surgical Journal*, 1875–1876, iii.

In 1916 Colonel Charles Franklin Craig shewed that an epidemic of amœbic dysentery among troops on the Mexican Border was transmitted principally by flies (*The Military Surgeon*, March and April, 1917, xl, 286; 423). In 1940 the same officer advised weekly doses of Diodoquin as a prophylactic against this disease, for troops whose water supply may be polluted (*American Journal of Tropical Medicine*, 1940, xx, 799).

Cholera was one of the early problems considered by the Board for the Study of Tropical Diseases in the Philippines. The proximity to great centers of cholera in China and India, the personal habits of the natives of the Islands all combined to give a perfect background for cholera epidemics. Such an outbreak occurred in 1902. It was estimated, and the estimate was probably too low, that there had been, in 1902, 128,000 cases with 81,500 deaths. The epidemic was declared ended on 23 March 1904. It was then reported that there had been 166,252 cases with 109,461 deaths. These figures were considered far too low by the Commissioner of Health, Colonel Louis Mervin Maus (1851–1939), who thought there had been not less than 300,000 cases. Despite all this there were but 485 cases with 286 deaths in the Army in 1902, 149 cases with 96 deaths in 1903, and only one case and no deaths in 1904. Considering the conditions obtaining, the prompt control of an epidemic so widespread was a splendid accomplishment of the Army Medical Corps.

Cholera was once a military problem of the first magnitude, and some of the Army's early epidemiological studies are still valuable. Lieutenant-Colonel Joseph Janvier Woodward (1833–1884), for instance, published *Report on Epidemic Cholera in the Army of the United States during the Year 1866* (S.G.O. *Circular* No. 5, 1867) and *Report on Epidemic Cholera and Yellow Fever in the Army of the United States during the year 1867*. The report of Surgeon Ely McClellan made in 1873 in accordance with an Act of Congress, was published as a congressional document, while Billings's bibliography of cholera was the most complete up to his time.

Even a century and more ago, when bacteria were not yet known to exist, our Army Medical officers realized that cholera was a disease in some way associated with contaminated food. Witness the following paragraph from an order issued by no less a man than General Winfield Scott. This was fifteen years before his great campaign in Mexico. This order is dated Fort Armstrong, Illinois (now known as Rock Island Arsenal), 28 August 1832. After announcing that cholera had made its appearance on Rock Island, the order states:

"4. Sobriety, cleanliness of person, cleanliness of camp and quarters, together with care in the preparation of men's messes, are the grand preventives. No neglect under these important heads will be overlooked or tolerated.

"5. In addition to the foregoing, the Senior Surgeon present recommends the use of flannel shirts, flannel drawers and woollen stockings. . . ."[25]

This military order, issued on the recommenda-

[25] *The Military Surgeon*, June, 1935.

tion of the senior medical officer, made its appearance at a time when cholera was generally believed to be due to a state of the atmosphere and intemperance. Unfortunately we have not the name of the medical officer concerned. Possibly it was the colorful Thomas Lawson (1789–1861), who became Surgeon General in 1836 and held office until his death. Lawson was an intimate friend of General Scott and used to lend him small sums of money, as one of the General's letters shows.

THE VECTOR OF DENGUE DISCOVERED

The disease we now call dengue has long been know to the Army. Surgeon General Benjamin Rush (1745–1813) described it as *Bilious Remitting Fever*, under which name it was usually confused with yellow fever and malaria. Rush's treatise on dengue was the second (1780) written in America. The names *Breakbone Fever* and *Scarlatina rheumatica* have also been applied to this disease.

In 1906, Surgeon General Robert Maitland O'Reilly (1845–1912) reconstituted the U. S. Army Board for the Study of Tropical Diseases and put it to work in Manila. His letter of instruction directed that "The specific cause of dengue should be sought for and its alleged conveyance by the mosquito be confirmed or disproved" (Ashburn, 278). The Board had an early opportunity to observe this disease, for there was an outbreak shortly after they began their work. Their report described the epidemiology and semeiology of the disease, showed that it is due to a filterable virus, incriminated the mosquito, and recorded the experimental transmission of the disease by the bite of *Culex fatigans*, as the insect was then known.

Subsequently it was found that the transmission by *Culex fatigans* was reported in error, being probably due to an accidental infection of the person concerned.

In 1926 later members of the Tropical Board confirmed work done in Australia and showed that the vector is *Aëdes ægypti*, the same insect that transmits yellow fever. This splendid piece of work was done by three medical officers: Joseph Franklin Siler, Milton Weston Hall and Arthur Parker Hitchens. Their monograph was published in Manila, 1926.[26] They shewed that *Culex quinquefasciatus* does not transmit dengue, but their principal work was the demonstration, by human experimentation, of the exact mechanics of transmission by *Aëdes ægypti*.

[26] See also *J. Am. Med. Association*, 18 April 1925.

THE FIGHT AGAINST ALCOHOLISM

With the memory of our recent prohibition folly all too green, one hesitates to cite an early attempt to reduce alcoholism as one of the accomplishments of Army medical officers. Yet an advance it was. During our two wars with the Mother Country it was expected that soldiers be allowed to drink, and usually drink to excess. The drunken soldier who figures in plays and novels was no imaginary character. Military efficiency suffered, but the idea of preventing drunkenness seems hardly to have occurred. There was issued a "rum ration" to soldiers and any curtailment of this privilege, nay right, would have shattered discipline and morale. At least that is what officers seemed to think.

Surgeon General Lovell, who has many things to his credit, attributed much of the illness of soldiers to excessive consumption of spirituous liquor, and he wrote about it and mentioned it in many of his reports. Finally his advice and opinion caused the discontinuance of the rum ration, which has not existed in our army for more than a century. None can gainsay that we have better soldiers as a result. Many men would drink their daily tot of rum who otherwise would not have become too fond of the cup.

Benjamin Rush, writer on so many subjects, did not neglect the consideration of alcoholism. His *An Enquiry into the Effects of Spirituous Liquors upon the Human Body, and their influence upon the Happiness of Society* (n.d.) was republished in 1811 and in several later editions.

Alcoholism was such a problem to military commanders in the field that in 1832 General Winfield Scott adopted a suggestion made, it is said, by his intimate friend, the future Surgeon General Thomas Lawson (1789–1861). In General Order No. 16, issued from Fort Armstrong, Illinois (now Rock Island Arsenal) General Scott called attention to the dangers of inebriety and the virtues of temperance, and then added these paragraphs:

"6. The General therefore preëmptorily commands that every soldier or Ranger who shall be found drunk or sensibly intoxicated after the publication of this order, be compelled, as soon as his strength will permit, to dig a grave at a suitable burying place large enough for his own reception, as such grave cannot fail soon to be wanted for the drunken man himself or some drunken companion.

"7. This order is given as well to serve for the punishment of drunkenness as to spare good and

temperate men the labor of digging graves for their worthless companions."[27]

One is reminded of a remark made by General Scott: "I am in the habit, myself, when on duty with troops, of paying great deference, and even of yielding my opinion, on matters deeply affecting the health and life, to the advice of my medical staff."

Some military companies used to save up their daily rum ration until a large amount had been accumulated, and then spend a week in wassail. In the early days of the nineteenth century the surgeon at Fort McHenry, Maryland, where our National Anthem was written a few years later, persuaded the commanding officer to abolish the rum ration. He showed that the death rate from pneumonia was high because so many debauchees would lie exposed to the elements after sprees that would have done credit to the vikings of old. It was perhaps this experience at prohibition which enabled Surgeon General Lovell to convince the War Department that soldiers were better off without the rum ration.

In 1894, at the instance of The Committee of Fifty for the Investigation of the Liquor Problem, Surgeon John Shaw Billings made a valuable bibliography of alcoholism, and edited the volumes on the subject published by this committee. This was no bit of prohibition propaganda, but a scientific study leading to valuable conclusions.

ARMY OFFICERS WRITE MEDICAL HISTORY

No group of Americans have contributed more extensively to the fascinating field of medical history than Army officers. Both official publications and unofficial ones have attested the real study into the past of the healing art and science. With the world's largest library in its custody and its rich treasures at the disposal of medical officers who will read, it is small wonder that this is so.

Of the official publications bearing on medical history one first thinks of the series of *Annual Reports* of the Surgeon General. This valuable series is well over a century old and each year one volume is added. The earlier volumes are so rare that only two or three copies are known, though these have been photographed throughout. When General Gorgas was Surgeon General he kept this series in his private office and no officer could borrow one of the earlier volumes without asking the Surgeon General for it personally. And that was during the busy days of the World War. I remember being sent by my chief, Colonel Deane Childs Howard, head of the Division of Sanitation, to borrow one of these precious books and of how General Gorgas warned me not to lose it unless I wanted to lose my commission. Despite the twinkle in his kindly eye I knew that he meant what he said.

Two monumental histories of our service in the country's two greatest modern wars (excepting the present one) have been published under the supervision of the Surgeon General. The first was *The Medical and Surgical History of the War of the Rebellion*, a work of three medical volumes, totaling 2526 pages, and three surgical volumes of 2320 pages in all.

Prof. Rudolf Virchow said of *The Medical and Surgical History of the War of the Rebellion:*

"Whoever takes up and reads the extensive publications of the American medical staff will be constantly astonished at the wealth of experiences found therein. The greatest exactness of detail, careful statistics, even about the smallest matters, and a scholarly statement embracing all sides of the medical experience, are here united in order to transmit to contemporaries and posterity in the greatest possible completeness, the knowledge purchased at so vast an expense."[28]

For our work in the first World War there was published a series of nineteen quarto volumes, 160,291 pages in all, under the title *The Medical Department of the United States Army in the World War*. The volumes required several years for completion, and were under the editorial supervision of a board consisting of Colonels Charles Lynch, Joseph Herbert Ford, Frank Watkins Weed and Dr. Loy McAfee, contract surgeon. The work is a most valuable reference and represents the only official history of America's effort in the World War that has appeared so far, though there has been a large group of officers working for more than twenty years on the general history of that war. Unfortunately the Medical Department's history is something like Hamlet with Hamlet left out, for the General Staff ordered that personal references be omitted, a decision that historians naturally find unfortunate.

[27] Order reprinted in *The Military Surgeon*, June 1935.

[28] Quoted by Dr. William Gerry Morgan, *The Military Surgeon*, June 1930, lxvi, 781.

Now that we are engaged in another World War, no time has been lost in making preparations for its medical history. Brigadier-General Albert Gallatin Love, the Army's best known vital statistitian, has already been charged by the Surgeon General with the collection of historical data on the war. He is not attempting the writing of the history, but he is gathering material, much of which would otherwise inevitably be lost amid the stress and excitement of war. A recent *Army Medical Bulletin* (No. 60, published at Carlisle Barracks, dated January 1942) gives the outline of the proposed history.

The Medical Department has published also, from time to time, valuable monographs. There used to be what were called "Circulars," a most inadequate term for large and exhaustive studies of special subjects. Edited in the Surgeon General's Office are quarterly publications, *Army Medical Bulletin* (began 1923), *Army Dental Bulletin* (began 1932) and *Army Veterinary Bulletin* (began 1926), all published at the Medical Field Service School at Carlisle Barracks, Pennsylvania.

Of the unofficial works first place must of course be given to the great *Introduction to the History of Medicine* by Colonel Fielding Hudson Garrison (1870–1935). Garrison is probably the best known medical historian that the country has produced. From his gifted pen flowed many an article, monograph and erudite study of medical history in its varied phases. His *Notes on the History of Military Medicine* (1922) is a worthy companion, albeit a far smaller one, of his great medical history.

The first American work on medical biography was published, 1828, by Assistant Surgeon James Thatcher (1754–1844), so that in a sense he is our first medical historian. His remarkable *Military Journal during the American Revolution* (1826) gives an authoritative description of Arnold's treason, André's capture and an appreciation of Washington's character.

An examination of the volumes of the *Annals of Medical History*, *Medical Life*, and the *Bulletin of the History of Medicine* of Johns Hopkins will show that no group of contributors have been more prolific writers on medical history in this country than officers of the Medical Corps of the Army. Lack of space precludes consideration of the many volumes of individual additions to medical history. Through its fifty years, *The Military Surgeon* has published valuable historical material by Army medical officers.

SANDFLY FEVER AND OTHER FEVERS OF SHORT DURATION

Besides the studies of dengue, American Army medical officers have studied other fevers of short duration and uncertain etiology. In *The Military Surgeon* for September, 1912, Major (now Colonel, retired) Eugene Randolph Whitmore wrote *Fevers of Undetermined Causation*. He considered fevers of ten to fifteen days duration which could not be diagnosed by methods then known. He considered such maladies to be possibly related to dengue or Malta fever.

Sandfly Fever has long been studied by the Royal Air Force Medical Service, whose officers have made important contributions to our knowledge of this militarily important disease. Though it has not been a problem in the United States as yet, it might become so with the ever present modern danger of transmission of infected insects by aircraft. A number of United States Army Medical officers have studied the disease abroad. Colonels Percy Moreau Ashburn (1872–1940) and Charles Franklin Craig in their *Experimental Investigations Regarding the Etiology of Dengue with a General Consideration of the Disease*[29] noted the similarity of dengue and pappataci (sandfly) fever. It has always been difficult to differentiate these conditions. Craig wrote other papers on this subject, including *On the Nature of the Virus of Yellow Fever, Dengue and Pappataci Fever*[30]; also the article on this disease in *Appleton's Practical Libary of Medicine and Surgery* (1938). Colonel Edgar Erskine Hume wrote the chapter on Sandfly Fever for *Tice's Practice of Medicine* (1925; second edition, 1939), in which he told of his personal experience as a patient with sandfly fever, and compiled the first complete bibliography of the disease.

ANTHROPOLOGY AND ETHNOLOGY

Anthropology (particularly anthropometry) and ethnology have been subjects in which our Army medical officers have made early and valuable studies. First in the days of warfare and marches on the plains there was ample opportunity to study the American Indian and his customs. Later there was a similar opportunity to study the natives of the Philippine Islands. Besides this, medical officers have studied our own popu-

[29] *Philippine J. of Science*, 1907, ii, 93–146.
[30] *N. Y. Med. Journal*, 1911, 93, 360–369.

lation, and some of them have devoted their attention to studies of the Negro.

The first contributions made in the country to the then unknown science of anthropology were made, 1774–1788, by the many-sided Surgeon General Benjamin Rush.

Lieutenant-Colonel Charles Edward Woodruff (1860–1915) is perhaps the Army's best known ethnologist. His work was done largely in the Philippines, where he wrote his monograph, *The Effects of Tropical Light on White Men* (1905) (see his chapter on Study of the Effects of Ultraviolet Light). This work was considerably expanded and republished as *Medical Ethnology* (1915). Better known is his *The Expansion of Races* (1909), which his enthusiastic admirers have called the most outstanding contribution to the literature of anthropology since Darwin's *Origin of Species*. It consists of an absorbingly interesting collection of anthropological and ethnological material to which he endeavored to give interpretation.

Woodruff wrote more than seventy articles, chiefly on military medicine and related fields, many being on anthropology. Among the best of these are *An Anthropological Study of the Small Brain of Civilized Man and its Evolution;*[31] and *Evolution of Modern Numerals from Ancient Tally Marks.*[32] He contributed the article on *Medical Ethnology* in the third edition of the *Reference Handbook of the Medical Sciences* (1914). In his last years he was associate editor of *American Medicine*, in which journal he had opportunity to record his views on ethnology and anthropology.

Another gifted anthropologist of the Army Medical Corps was the eccentric Major Robert Wilson Shufeldt (1850–1934). His work as an ornithologist is considered in the chapter on that subject. He was a prolific writer, having more than 1800 titles to his credit, which varied in length from brief communications to the newspapers to ponderous monographs. While stationed in the West he studied the Indians, particularly those of Arizona and New Mexico. His studies of the Zuñis are especially valuable. His paper on this subject is in *Science*, 25 September 1885. His study *The Mortuary Customs of the Navajo Indians*[33] is particularly worthwhile. In later life, after retirement, he devoted some study to the American Negro and published several papers, the best known of which is *America's Greatest Problem: The Negro* (1915). Some of his photographs of unclad subjects as well as papers on sexual aberrations aroused the fears of Mr. Anthony Comstock and a private "war" between them ensued, in which neither spared the other.

Another great ornithologist of the Army Medical Corps who likewise did valuable work in anthropology was Surgeon Elliott Coues (1842–1899). Unfortunately Coues managed to mix a certain amount of theosophy with his anthropological work so that it must be studied with this in mind. Some of his works are an edition of Robert Dodsley's *True and Complete Economy of Human Life*, *The Daemon of Darwin* (1884), *A Woman in the Case* (1887), *Neuro-Myology* (1887).

Special anthropometric studies growing out of medical officers' experience in the War Between the States are reflected in such works as Surgeon General Jedediah Hyde Baxter's (1837–1890) *Statistics, Medical and Anthropological, of the Provost-Marshal-General's Bureau, Derived from Records of the Examination for Military Service in the Armies of the United States in the late War of the Rebellion, of Over a Million Recruits, Drafted Men, Substitutes, and Enrolled Men* (2 volumes, 1875). This great work has always been considered a classic. Even earlier the United States Sanitary Commission, as one of its memoirs, published *Investigations on the Military and Anthropological Statistics of American Soldiers* (1869). A veteran of that same war, the distinguished editor of the *Index Medicus* and the intimate associate of the great Billings, was Colonel Robert Fletcher (1823–1912), who was interested in anthropology among other sciences. He wrote *Human Proportion in Art and Anthropology* (1883), based on his lectures delivered at the National Museum, Washington. In the previous years he had published his valuable monograph, *Prehistoric Trephining*. He wrote also in a most fascinating way on medical folk-lore.

Acting Assistant Surgeon Henry Crècy Yarrow (1840–1929), who became a Lieutenant Colonel in the Medical Reserve during the World War, had more than thirty years of military service serving in many expeditions into the West while attached to various surveys. He wrote much in ornithology, ichthyology and herpetology. His anthropological writings, too, were important, particularly his *Mortuary Customs of the North American Indians* (1880–1881).

[31] *Am. J. of Insanity*, July 1901.

[32] *Am. Mathematical Quarterly*, August, Sept., 1909.

[33] *Am. Naturalist*, April 1891.

Another Army medical officer who worked in anthropology of American Indians was Major Washington Matthews (1843–1905), who gave particular study to Navajo folk-lore. He also wrote *On Measuring the Cubic Capacity of Skulls*, (1845); *The Inca Bone and Kindred Formations among the Ancient Arizonians*,[34] *Use of Rubber Bags in Gauging Cranial Capacity*,[35] etc.; the *Index Catalogue* lists his numerous writings.

The anthropometric value of the records kept by medical officers of the Army was stressed by Colonel Woodward in his address before the International Congress of Medicine, Philadelphia, 1876 (p. 294). Speaking of the reports of the physical examinations of soldiers, he showed that they include the name, nativity, former occupation, age, social condition, height, weight, chest-measurement, complexion, color of eyes and hair, as well as the cause of disability or rejection if any. "The observations made by hundreds of well educated men, stationed at many different places, must contain a great deal of information of no little interest in connection with interests of progress in scientific medicine and surgery. Without their intelligent analysis, the Surgeon-General of the Army, whatever his personal ability, would be but a figure-head, powerless for any efficient interference in behalf of the health of the Army." In the same address, Woodward cited a number of the official *Circulars* of the Surgeon General's Office, War Department, which included such material.

In anthropometry one must consider also the great *Medical and Surgical History of the War of the Rebellion* and the *Medical Department of the United States Army in the World War* as vast storehouses of information. Particularly important too is General Albert Gallatin Love's *Defects Found in Drafted Men* (1920). Studies of the anthropometry of Filipinos are found in many of the volumes of the *Philippine Journal of Science.*

CONTRIBUTIONS TO NEUROPSYCHIATRY

The first American work on insanity was written by Surgeon General Benjamin Rush, 1812. Mills pronounced this to be, with that of Isaac Ray, the only systematic American treatise on the subject before 1883.[36]

Surgeon General William Alexander Hammond (1828–1900) first described the condition *athetosis* (1873). He was the founder and editor of the *Journal of Nervous and Mental Disease* (1867–1883). He was likewise editor of the *Quarterly Journal of Physiological Medicine and Medical Jurisprudence* (1867–1872), and the *New York Medical Journal* (1867–1869). Upon quitting the military service, as a result of his disagreements with Secretary of War Stanton, 1864, he was appointed lecturer in nervous and mental diseases at the College of Physicians and Surgeons, New York. He rapidly became the leader in his specialty in the metropolis. In 1867 he resigned his chair at the College of Physicians and Surgeons and accepted the professorship of Neurology and Psychiatry at the Bellevue Hospital Medical College. In 1874 he was given a similar appointment at the medical department of the University of the City of New York. In 1888 he removed to Washington and established a large sanitorium for the care of mental and nervous patients. He was a pioneer in the use of animal extracts in therapeutics.

The important monograph *Gunshot Wounds and other Injuries of Nerves*, 1864, by Acting Assistant Surgeons Silas Weir Mitchell (1830–1914), George Read Morehouse (1829–1905) and William Williams Keen (1837–1932), has been mentioned in the chapter on Surgery of Gunshot Wounds. This monograph was expanded and in 1872 published as *Injuries to Nerves and their Consequences.*

The medical volumes of the *Medical and Surgical History of the War of the Rebellion* contain worthwhile contributions to psychiatry and neurology.

In the *Journal of the American Medical Association* for 1900 (xxxv, 1098) Colonel Charles Smart (1841–1905) published *Alleged Insanity in the Army*, a valuable contribution to the study of malingering.

Malingering has been considered at length by a military surgeon of the present day, Colonel Edgar King. King published *Mental Disease and Defects in United States Troops* in 1914. It is a monograph of 204 pages, issued as *Bulletin* No. 5, Surgeon General's Office, War Department. It not only gives the account of conditions then prevailing, but reviews the past experience of military surgeons. Colonel King began in *The Military Surgeon* for 1915 a series of interesting articles on *Military Delinquency*, a subject of which he made a careful study extending over many years

[34] *Am. Anthropology*, 1889.

[35] *Ibid.*, 1898.

[36] C. K. Mills, *Benjamin Rush and American Psychiatry*, 1886.

Colonel King (then Captain) was the head of the Department of Sociology and Psychiatry at the United States Disciplinary Barracks, Fort Leavenworth, Kansas, 1915–1917, a department that he created. It did much good in its study of delinquent soldiers and in the selection of those capable of restoration to honorable duty status. The writer was Colonel King's assistant in 1917 and was, for a short time, his successor in charge of the work just prior to the entrance of the United States into the World War. Colonel King is now the senior medical officer in Hawaii and his carefully planned arrangements for the medical service brought him much favorable comment amid the general criticisms of unpreparedness for Japanese attack.

One of the seventeen volumes of *The Medical Department of the United States Army in the World War* is entitled *Neuropsychiatry* (Vol. X). In some 543 pages it tells the story of our experience with nervous and mental disease in the first World War, including the service in Europe and that in our own country.

In *Circular* No. 19, 12 March 1941, the Surgeon General stressed the importance of careful mental examination of men entering the military service. He added:

"During the period April 1, 1917, to December 31, 1919, no less than 97,657 patients were admitted to hospital for neuropsychiatric diseases. The major subclassification grouped 8,731 for epilepsy; 8,028 for neurasthenia; 4,310 for neurocirculatory asthenia; 6,090 for hysteria; 5,146 for constitutional psychopathic states; 13,063 for mental deficiency; 6,249 for dementia præcox; 7,501 for psychoneuroses; 5,652 for other types of psychoses, and the remaining ones for various types of neuropsychiatric disorder. The above brief analysis indicates the necessity of careful neuropsychiatric study in all questionable applicants upon their examination at recruiting or induction stations.

"The soldier must be looked upon as a fighting unit requiring certain limited and definite qualifications. Not all types of individuals are adaptable to restrictions and inhibitions of personal desires and comforts, nor to the deprivation of rest, food, shelter, and, as the occasion oftimes arises, to extraordinary demands of prolonged physical and mental activity during active military service. It must be remembered that many individuals of abnormal personality traits, who are capable of satisfactory adult adjustment in civilian life, where numerous avenues of escape are available, will be at a total loss to adjust themselves to a pattern which is more or less inflexible and, of necessity, delimited and circumscribed as to self-expression. When thrown on their own meagre resources of adaptation in army environment, in contact with all kinds of personalities, some who are just able to adapt themselves to life under the most favorable conditions will not fit into the one iron mold which experience has taught is essential to military success."

STUDY OF THE EFFECTS OF ULTRAVIOLET LIGHT

In our everyday acceptance of the popular belief of the beneficent effects of sunlight we must not forget that this is somewhat a new concept. The carefully darkened homes and hospitals, the sunbonnets and sombreros in wide use all pertain to a day when strong light was feared. A pioneer in the scientific study of the effects of sunlight, both good and bad, was Lieutenant-Colonel Charles Edward Woodruff (1860–1915), an officer trained at the U. S. Naval Academy and for a time a naval medical officer before entering the Army as an Assistant Surgeon. Woodruff is best known for his monograph *Effects of Tropical Light on White Men* (1905). He held that the deleterious effects of tropical residence are due to the influence of the actinic rays of the sun. This accounts for, he said, the better adaptability of brunettes to tropical life. Upon his recommendation underclothing of orange or red was tried, with the idea of keeping out harmful rays. Though later work tends to show that the combination of heat and humidity is more important in the physiological changes in hot climates, Woodruff's work must be considered of great value in the development of present concepts. Colonel Woodruff was the editor of *American Medicine.*

PIONEER WORK IN ROENTGENOLOGY

It was on 8 November 1895 that "a light was first detected which, according to human observation, had not been on land or sea." So was Prof. Wilhelm Conrad Roentgen's discovery of the x-rays described by a British contemporary. The medical profession of the world was at once thrilled at the possibilities offered by this mysterious power. None thought of any danger associated with the new rays.

The Army's medical officers became interested in the new discovery immediately. The Spanish-American War followed soon after Roentgen's work was published and for the first time there was a practical opportunity for the use of x-rays in locating bullets and other missiles. Wise Surgeon General Sternberg gave his immediate and enthusiastic support to the use of roentgenological equipment in the field and in hospital. The Army's experience with the use of x-rays was set forth by one of its distinguished operating surgeons, Captain William Cline Borden (1858–1934), later Lieutenant-Colonel, who published *The Use of Roentgen Rays in the Medical Department of the U. S. Army in the War with Spain*, 1900. It was issued from the Government Printing Office under the direction of Surgeon General Sternberg.

Commenting on the Army's Spanish War experience, Colonel Nicholas Senn (1844–1908), a distinguished military surgeon and founder of the Association of Military Surgeons of the United States (1891), wrote:

"The x-ray has fully answered the expectations in military surgery as a diagnostic resource. The limited experience with this diagnostic aid during the Spanish-American War has fully demonstrated its great value in military surgery. It may be relied upon in locating bullets in almost any part of the body and in ascertaining, in doubtful cases, the existence, the location and nature of fractures, and in determining the exact location of the fragments. . . . The probe, so constantly relied upon in the past in locating bullets, is an instrument of uncertain diagnostic value, and its use is always attended by more or less risk of infection. . . . The probe is as objectionable in the examination of a compound fracture as in exploring the track of a bullet. The x-ray has a great future in this part of military surgery. . . . The fluoroscope has greatly enhanced the diagnostic value of skiagraphy in military surgery."[37]

With the enthusiasm over the new aid to surgical and other diagnosis there was no thought of danger. Many pioneer radiologists were unduly exposed to the mysterious rays, for the early apparatus was built without protection for the operator. Particularly dangerous was the fluorescent screen. As late as 1901 one textbook said: "A simple way of testing the quality of the light (penetration of the rays) is to examine the hand with the fluorescent screen."[38] There was always the desire to demonstrate the rays to the curious and for the operator to test them upon himself in the nervous patient's presence. The tragic consequences of all this have been described in Percy Brown's *American Martyrs to Science through the Roentgen Rays* (1936). The terrible burns and malignant growths that have stricken down radiologists form a sad story indeed.

One of the first of these martyrs was a woman who worked with and for the Army's military hospital in San Francisco, now known as the Letterman General Hospital. She was Mrs. Isadore Ascheim (née Elizabeth Fleischman) (1859–1905). Though not a physician or nurse, Miss Fleischman became interested in her brother-in-law's work with the newly discovered roentgen rays, and made excellent negatives even with the primitive apparatus then available. She had been at work for about a year when the patients from the Spanish-American War began to arrive in the Presidio Division Hospital, San Francisco. As a volunteer she helped the Army Medical officers with this work. Some of her pictures illustrate Captain Borden's monograph above mentioned. But she was herself unprotected. Epidermoid carcinoma of the arm resulted, and though the arm was amputated metastases to the lung resulted in her untimely death.

The first medical officer of the Army who suffered death from roentgen rays was Eugene G. Northington (1880–1933). Unfortunately his name is not among those of the twenty-eight martyrs listed in Percy Brown's book mentioned above. He developed malignant growths of both arms. First one, then the other was amputated. He was retired for disability and lived for nearly twenty-four years before death put an end to his sufferings. At the time of his death, Brigadier-General Edward Lyman Munson wrote:

"More than twenty years ago he and I served together. His hands, burned as if by fire, even then showed the development of cancerous nodules. This, to both of us as doctors, had only one significance, one ending. Yet he faced the future undaunted, without repining and interested only in that what was left of him of life should be turned to the advantage of others. . . . During a term of many years, Colonel Northington underwent seventy-six surgical operations for the removal of

[37] "The X-Ray in Military Surgery," *Phila. Med. J.*, 1900, v, 36.

[38] F. H. Williams, "The Roentgen-Rays in Medicine and Surgery," p. 46.

successive cancerous growths. Fingers, hands, and both arms were ultimately lost, and he became wholly dependent on the ministrations of others. Finally growths extended through the body and surgery could do no more. . . . His unfailing fortitude challenged the admiration of his associates, and his cheerful unselfish personality won the affection of all who knew him."[39]

Northington was working at the Army Medical Museum when one arm was amputated and he asked that it be sent to that institution for study. He was even able later to laugh about the privilege he had of seeing his arm properly preserved, comparing it to General Sickles's leg, which had also been sent as a specimen to the Museum.

He died in the Letterman General Hospital, San Francisco, an institution he had once commanded. Munson, agreeing with others who knew him, characterized him as "one of the bravest soldiers I ever knew."

Another radiologist who gave his life to his science was Frederick Henry Baetjer (1874–1933), Professor of Radiology at Johns Hopkins. Despite mutilations resulting from x-rays, Baetjer volunteered for military service when the United States entered the first World War. Surgeon General Gorgas waived his disabilities and he was commissioned a Major in the Medical Reserve Corps. Thus he was able to continue his active teaching of radiology, being put in charge of a special school maintained by the Medical Department of the Army for training technicians and diagnosticians.

Eugene Wilson Caldwell (1870–1918), though already seriously injured by roentgen rays, served as a Major, Medical Reserve Corps, in the first World War. He had been one of the first of his specialty to enter the old Medical Reserve Corps prior to the creation of the Officers Reserve Corps that we now know. Despite great suffering at the end of his life he was able to complete the task assigned him by the Surgeon General, though some of his equipment was described only after his death, which occurred during the war.[40]

More happy in his work with roentgen rays has been Arthur Carlisle Christie, who learned the new science while an officer of the Medical Corps of the Regular Army. He resigned as a Captain in 1916 but in the following year, with the entrance of the United States into the First World War, he returned to active service as a reserve officer, rising to the grade of Colonel. He has been Professor of Roentgenology at George Washington University since he left the service. In 1913 he published his *Manual of X-ray Technique*, second edition, 1917. In 1924 this was enlarged as *Roentgen Diagnosis and Therapy*. Dr. Christie has been president of the American Roentgen Ray Society and of the American College of Radiology.

DEFENSE AGAINST WARFARE GASES

If supposedly civilized nations confined their warfare to attacks on the enemy's troops, the matter of defense against warfare chemicals would be a purely military problem, and therefore beyond the scope of this study. But such is far from the case. In these days of total warfare, the civilians, including women and children, are subject to attack at all times. So the work done by the Medical Department of the Army towards protecting the general population from gases and other chemicals of war represents scientific advance of interest in the country's entire population.

In 1925 Lieutenant-Colonel (now Colonel, retired) Edward Bright Vedder published his monograph *The Medical Aspects of Chemical Warfare*, a work in which the experiences of the first World War were reviewed and the various chemical warfare agents considered. There was full discussion of the means of both individual and collective protection against such chemicals. Vedder was in charge of the Medical Research Laboratory of the Chemical Warfare Service at Edgewood Arsenal, Maryland, an institution which continues its important work.

Vedder's successor at the laboratory at Edgewood was Colonel Harry Lorenzo Gilchrist, who had been in charge of similar work in the American Expeditionary Forces in the late war. Gilchrist later was appointed Chief of the Chemical Warfare Service with the rank of Major-General. He wrote much on the medical side of that service's work. For instance, *Chemical Warfare and its Relation to the Medical Department;*[41] *The Humanity of Chemical Warfare;*[42] and *Chemical Warfare and its Medical Significance.*[43] Gilchrist also showed from the Medical Department's statistics of the World War that tuberculosis is not induced

[39] *The Military Surgeon*, August, 1933.

[40] Cf. Capt. L. Middleditch, Sanitary Corps, U. S. Army, "A Description of the Caldwell Fluoroscope," *Am. J. Roentgenology*, 1918, v, 547.

[41] *The Military Surgeon*, 1923.

[42] *Ibid.*, 1925.

[43] *Ibid.*, 1928.

by previous exposure to warfare gases.[44] Several of Gilchrist's monographs were published by the Chemical Warfare Service.

Another director of the Edgewood laboratory was Major Cyrus Boynton Wood (1889–1939), who wrote *The Chemistry of Chemical Warfare Agents and Protection Against Them.*[45]

In September, 1926, Colonel Vedder published in *The Military Surgeon*, a paper called *Chemical Warfare: What Shall be the Attitude of the Association* [of Military Surgeons], *on Resolutions Abolishing it?* He stressed the old argument that chemical warfare is more humane than firearms. He took the sound position that medical officers are not concerned with recommending policies as to warfare. All this was apropos of the protocol of Geneva of 1925, banning chemical warfare, and a proposed resolution of the Association of Military Surgeons of the United States opposing its ratification.

The introduction of copper sulphate in the treatment of burns by white phosphorus was the result of investigations made at the Medical Research Laboratory at the Army's Edgewood Arsenal, by Commander Duncan Cameron Walton, (1886–1942), Medical Corps, U. S. Navy.[46]

STUDY OF THE HUMAN FOOT AND ITS PROPER SHOE

Army officers have always realized the importance of proper footgear for the soldier, and for other persons who must walk for long distances. Marshal Niel once said that shoes for his infantry were of equal importance with mounts for his cavalry. The Duke of Wellington's opinion of the three most essential parts of a soldier's equipment was as follows: a pair of good shoes, a second pair of good shoes, and a pair of half soles.

In 1908 our War Department appointed a board of officers to study the subject. The Army Shoe Board, as it was called, consisted of Major (now Brigadier-General, retired) Edward Lyman Munson, Medical Corps; Captain (now Brigadier-General, retired) William Jefferson Glasgow, General Staff; Captain (later Colonel, Quartermaster Corps) John Robert Rigby Hannay (1875–1938), 22nd Infantry; and First Lieutenant (now Colonel) Benjamin Franklin Miller, 27th Infantry. The Board worked for four years including "the critical study of the feet of some 2000 soldiers, the fitting of many thousands of pairs of shoes, and many months of direct inquiry into the causes affecting the shoeing of the United States soldier." The work of the Munson Board, as it is sometimes called, was published by General Munson in his now famous monograph, *The Soldier's Foot and the Military Shoe*, (1917).

Munson considered the subject exhaustively and described the last for the shoe of the soldier that he considered met all requirements. This is the well-known "Munson last," which is still used in our own and in a number of other armies. It is likewise extensively used by many civilians who must walk for long distances. Shoes built on this last are comfortable, long wearing, and of neat appearance. How few of the thousands of salesmen who sell boots and shoes built on the Munson last have any idea of the origin of the name.

In *The Military Surgeon* for February 1912, (pp. 170–211), Captain (now Colonel) Frank Watkins Weed published *A Study of the Foot and Foot Wear.* He considered the subject thoroughly and stressed the importance of a proper understanding by all those who have to do with soldiers or others who must walk long distances. He concluded that visual examination alone does not reveal the "potentialities of a given foot." The strength of a foot varies in proportion to that of the supinator group of muscles. Foot weakness may be prevented by proper exercise, and incipient weakness may be detected by use of suitable apparatus. The soldier's shoe as issued has several defects, chiefly disproportion between front and back. A proper last should be devised. Stockings should not be too small.

JAMAICA GINGER PARALYSIS

Such is the rapid expansion of medical knowledge that the profession has all but forgotten one of the sad by-products of prohibition, a strange malady known as Jamaica Ginger Paralysis, or more familiarly as "Jake Paralysis." It first appeared in 1930 and before the cause was ascertained it is estimated that as many as 10,000 or 15,000 persons were affected. It was found that the cause was an impurity in a certain manufacturer's Fluid Extract of Ginger (U.S.P.), a product containing alcohol but which could be sold legally. The compound causing the paralysis was shown to be tri-orthocresyl phosphate.

[44] "Warfare Gas and Tuberculosis", *The Military Surgeon*, 1924.

[45] *Ibid.*, 1928.

[46] *J. Am. Med. Assoc.*, 23 May 1925, lxxxiv, no. 21, 1569–1570.

The resulting paralysis was a form of multiple peripheral neuritis, somewhat resembling Landry's ascending paralysis. Upon the discovery of the cause, steps were taken to prevent the sale of the contaminated fluid extract of ginger, and there were no more cases of the malady.

Several enlisted men of the Army were among the earliest victims of the deadly ginger extract. The report on these men was one of the first published, though later the literature relating to "Jake Paralysis" became quite large. The cases were seen at the Station Hospital, Fort Benning, Georgia, being later transferred to the Army and Navy General Hospital at Hot Springs, Arkansas. The cases were treated under the direction of the Chief of the Medical Service, Major Samuel Augustus White and the Medical Inspector, Major Edgar Erskine Hume. The latter described the outbreak in *The First Cases of Jamaica Ginger Paralysis in the United States Army*,[47] and in *The Outbreak of Jamaica Ginger Paralysis in the United States*.[48]

STUDY OF DENTAL FOCAL INFECTION

It was one of our great military surgeons in the days of the country's youth who first suggested that infected teeth could be the cause of general disease. This was Surgeon General Benjamin Rush, protean man of genius.

The coöperation of dental and medical officers in the study and prevention of dental focal infection has been productive of good. Every member of the Army has a dental survey at least once a year, with resulting treatment as necessary. The decline in the admission rate for rheumatic fever has been striking. In 1900 the rate was 5.28 cases per 1000. In 1902 it was 5.22 per thousand. In 1926 it was 0.53 per 1000, and since that year it has remained less than 1 per 1000. Of course it is only fair to add that the Army's careful watch for diseased tonsils, and their removal, has contributed likewise to this reduction in rheumatic fever.

The matter is now too well known to require more than brief mention. Speaking to the Association of Military Surgeons, meeting at the Mayo Clinic in 1938, the chief of the Dental Corps of the Army†, Brigadier-General Leigh Cole Fairbank, said: "Perhaps nothing has contributed more to the interdependence of medicine and dentistry than our common interests in the elimination of dental sepsis. In a large series of cases of cardiovascular patients, almost 50 per cent had alveolar abscesses. In 40 patients with mixed types of endocarditis, nearly 75 per cent disclosed occult pus infection at root ends. The relationship between myocardial damage and dental infection is definitely established and its removal is essential for improvement in many cases."[49]

The Dental Corps, one of the components of the Medical Department of the Army, has made extensive studies of the effects of focal infection and must be credited with an important contribution to the sum of our knowledge of this subject.

This is one of the fields cited by General Fairbank to show the importance of closer bonds between medicine and dentistry. To quote his address further:

"Dentistry has been helpful to medicine in the past. The trends of today are significant to all of medicine. The envelopment of dentistry by medicine is perhaps one of the most encouraging signs of the times, and the successful and complete development of this trend will have important bearing upon all our studies in pure medicine. It will unquestionably more clearly define the dental aspects of preventive medicine."

If we recognize the importance of medicine enveloping dentistry, as stated above, we must credit General Fairbank with being one of the leading proponents of this change. He had behind him the weight of the Army's Medical Department. The Harvard Dental School's changed teachings reflect this new concept.

BACTERIOLOGY OF DENTAL CARIES

The pioneer in the United States in the study of bacteriology of dental caries was Major Fernando Emilio Rodriguez (1888–1932), a native of Puerto Rico and officer of the Dental Corps of the Regular Army. He is regarded by members of the dental profession as the greatest contributor to this subject since Muller, the German investigator of half a century ago.

Rodriguez's first contributions to dental research were made before he entered the military service. While serving with the Indian Medical Service he made extensive surveys of American Indians and reported that 80 per cent of those living in the Southwest were suffering with pyor-

[47] *The Military Surgeon*, Nov., 1930.

[48] *J. State Med.*, London, 1930.

† The actual title is: Brigadier-General, Medical Department, U. S. Army, Chief of the Dental Division of the Surgeon General's Office, War Department.

[49] *The Military Surgeon*, Jan., 1939.

rhœa, and concluded that the condition had much to do with reducing the vitality of the Red Men. He likewise found that dental decay and premature loss of teeth were as prevalent among Indian school children as among white children, though Indians living under more primitive conditions still had excellent teeth. He concluded that the use of foods requiring longer mastication, and less carbohydrate diet were responsible for the Indians' good teeth. He observed the mottled enamel of the teeth of many Indians and suggested that contaminated water supply may have played a part in its causation. This was long before the demonstration that fluorine content of drinking water was the cause.

His researches into the cause of dental caries began in 1921. By the development of special technique he was able to isolate and classify a high acid-producing group of bacteria, *Lactobacillus odontolyticus*, which he classified morphologically as Types 1, 2 and 3. He demonstrated that Type 3 is the primary etiological agent in enamel decay, identifying the organism with the flora in the dentinal tubules in caries. Writing in the *Military Dental Journal* (1932) he said: "We bring forward the view that there exists a definite species of bacterium where metabolic processes are in such harmony with favorable conditions which it may find upon the teeth that its growth and activity there amount practically to a selective localization." This same conclusion was reached by McIntosh, James and Lazarus-Barlow, British investigators, working independently, and whose work was not yet published and was unknown to Rodriguez. Rodriguez submitted the manuscript of his findings to the editor of the *Military Dental Journal* in March 1921, but the paper was not printed until the following December. In the meantime the British work was published in the *Lancet*, June, 1921. Thus Rodriguez lacks the priority that he would have had but for a chance circumstance.

In 1930 Rodriguez published his further studies in the *Journal of the American Dental Association*, a method for quantitative determination of the presence of *Lactobacillus acidophilus odontolyticus* in the oral cavity. In the following year he wrote in the same journal of the periodic fluctuations of *Lactobacillus acidophilus* in the mouths of individuals in the several age groups. He likewise demonstrated that the lactobacillus is present in large numbers in the saliva and deep in the active lesions of dental caries. He found that there is a mutation of *Lactobacillus acidophilus*, oral type, from the normal with loss of acidogenic power, with changed environment. He conducted at the same time a series of experiments on the relative merits of mercurochrome and iodine as dental disinfectants.

Rodriguez's work was recognized by his profession and the National Research Council appointed him a member of the Dental Investigation Committee. His work was cut short by his untimely death at the age of forty-four. A tablet in his honor was erected at the Army Medical School, 16 March 1940, by the American College of Dentists. The speakers at the dedication were Dr. C. Willard Camalier, President of the Dental Association, Honorable Oscar L. Chaplan, Assistant Secretary of the Interior, and the Rev. Arthur O'Leary, S.J., President of Georgetown University, where Rodriguez received his training. The ceremony was a part of the national celebration of the centenary of dentistry.

Rodriguez's brilliant work has been continued by several members of his Corps, notably Major Clarence Prince Canby, whose studies at the Army Dental School are about to be published. He has developed a vaccine for use in human inoculation.

Lieutenant-Colonel Rufus Wood Leigh, of the Dental Corps, published in *The Military Dental Journal* for December, 1923, *The Incidence of Caries in the Different Teeth and their Respective Surfaces*, said to be the first statistical study of the incidence of caries. Leigh has also made valuable contributions to anthropological studies of human skulls and teeth.

In the earliest days of the Dental Corps of the Army, one of its members became a leader in his profession. He was Captain John Sayre Marshall (1846–1922), the author of several textbooks in dentistry, and who did original work in dental pathology and technique. He organized the Northwestern Dental School in 1884 and was also a member of the faculty of the University of California.

DISEASES TRANSMISSIBLE FROM ANIMALS TO MAN

With the creation of the Veterinary Corps as one of the branches of the Medical Department of the Army by the National Defense Act of 1916, a new era began in the study of diseases of animals which may be transmitted to human beings. The officer who has done most in this field is the chief of the Veterinary Corps, Brigadier-General Raymond

Alexander Kelser. His most important contributions are the following:

Encephalomyelitis: Prior to Kelser's work the virus diseases known to be transmitted by the mosquito were yellow fever and dengue. Kelser demonstrated the transmission of equine encephalomyelitis by mosquitoes, ten species of *Aëdes* having already been shown capable of such transmission. The disease is known to be highly important medically, in that several thousands of human cases occurred last year in Minnesota, the Dakotas and adjacent Canada. The virus associated with this human disease has been found in naturally infected mosquitoes. This work has served to direct attention to the important possibility of insect transmission of poliomyelitis.

Rinderpest had long been a serious disease of cattle in the Philippine Islands before the American occupation, and handicapped the livestock and dairy industries. Major-General Leonard Wood asked that Major Kelser be assigned to study this problem. After two years' work, Kelser developed a vaccine against this disease. It is of uniformly high potency, safe for use, and prepared in a relatively short time. Within approximately five years of the introduction of Kelser's vaccine, rinderpest was eradicated from the Philippines. Thus 1800 *carabaos* (water buffalo) which formerly perished each year from this disease, have been saved.

Surra, a uniformly fatal equine disease caused by *Trypanosoma evansi* was a serious problem in the Philippines, and accounted on several occasions for wholesale loss of Army animals. While the vector had been considered the fly, there was great disagreement as to the species concerned. Mitzmain has suggested that *Tabanus striatus* was the vector, but it had not been proved. Kelser showed that this insect is indeed the agent, proving this in both experimental animals and in natural outbreak. Thus Kelser is to Mitzmain with respect to surra, what Walter Reed was to Finlay with respect to yellow fever. In both cases the Army officer proved what had previously been but a supposition.

Rabies vaccine, in which the virus is inactivated by chloroform has been introduced by Kelser. This vaccine is used in the immunization of both animals and man, and has been found more effective than vaccine made by other methods.

There have been other investigations of importance in human medicine done by our veterinary officers. Lieutenant-Colonels John Harold Kintner, Veterinary Corps, and Rufus Leroy Holt, Medical Corps, have done valuable research on equine osteomalacia. Lieutenant-Colonel Raymond Randall, at the Army Veterinary School, has done important work in producing a vaccine against equine encephalomyelitis. Though he did not originate this vaccine, he has made a number of improvements in the technique of its preparation. Chick embryos are used. Colonel Jean R. Underwood found that dhobie itch of equines in the Philippines is a verminous dermatitis. Lieutenant-Colonel François Hue Kari Reynolds has developed an antigen for use in a complement-fixation test for trypanosomiasis.

NURSING IN THE ARMY

The Medical Department of the Army may well claim an important share in the advancement of the nursing profession. As early as the War for Independence there was a demand for the services of women to aid in nursing the sick and wounded soldiers. In all subsequent wars there have been women nurses, sometimes serving on a wholly voluntary basis and at other times engaged by the Surgeon General or his representatives. Beginning with the work of the nuns of several orders, particularly those of the Order of Saint John of Jerusalem or Hospitallers in the centuries following the Crusades, nursing sisters have ever aided military patients. The existence of such women was a great step forward, for theretofore the only women associated with armies in the field had been camp followers who were usually more interested in well than in sick or wounded soldiers.

Advances in medical knowledge brought greater need for the service of women trained in technical work. It was the Army that gave such women their present social and professional position. Without such prestige even the great work of the Sanitary Commission during our Civil War and the Red Cross Societies of our own and other countries, would probably not have achieved that end.

The need of a special corps of women military nurses was recognized by Surgeon General after Surgeon General, until finally at the time of the Spanish-American War (1898), the scheme to create a Nurses Corps was approved. The Army Nurse Corps was established by Act of Congress, 2 February 1901, its members being appointed for terms of three years by the Secretary of War. From that time on the efficiency of this group of

women has increased steadily and they represent the best of their profession. In 1920 an Act of Congress gave the members of the Army Nurse Corps relative military rank, beginning with that of Major for the Superintendent down to Second Lieutenant for the juniors. It also provided the retirement privilege, thus making military nursing a career. In March, 1942, the Superintendent was given the grade of Colonel and the Assistant Superintendent that of Lieutenant-Colonel. This has greatly benefited the Nurse Corps. It has given them the needed military rank, thereby enabling them to exercise discipline in hospitals and elsewhere. It has likewise helped the status of the nurses in civil life. The United States Army is the first to give this recognition to its military nurses. There can be no doubt but that this may be called an advance worthy of inclusion in this study. Steps have been taken in 1942 to give rank to the members of the Navy Nurse Corps.

PREVENTIVE MEDICINE FOR THE CIVILIAN CONSERVATION CORPS

In 1933 when the Civilian Conservation Corps was created, the medical care of the young men enrolled was entrusted to the Medical Department of the Army. Medical officers had a problem comparable to that of a military mobilization. Though the members of the Civilian Conservation Corps had nothing of the military in their duties, they did live under camp and cantonment conditions similar to those of soldiers. Thus, while there were no battle casualties, the medical disabilities to be expected were similar to those of actual war.

The advances in preventive medicine that came in the fifteen years since the first World War were put to a practical test on wholesale scale. More than two and a half million men were examined and immunized against communicable disease. There was no outbreak of disease in epidemic form. It was probably the first time in all history that such a large group of men of military age had been brought together in camps and barracks without an epidemic of any kind.

When actual military mobilization came in 1940, the good effects of the C. C. C., medically speaking, became apparent. The members of the Civilian Conservation Corps having become largely immune to the common diseases which have usually accompanied mobilization, there was a very low incidence thereafter. It was found that ten per cent of the men who registered in September, 1940, for military service, had had service in the C. C. C. While there are no available statistics as to how many there are now in the military service, the number must be considerable.

The reduction in the incidence of measles, mumps, scarlet fever, and cerebrospinal meningitis over the rates of 1917, when we entered the first World War, and those of 1918, when that war ended, is striking. The following table gives these rates per 1000.

	1917	*1918*	*1941*
Measles	87.0	28.0	15.2
Mumps	39.0	75.0	6.8
Scarlet Fever	.8	4.4	2.0
Meningitis	4.1	1.3	0.1

The above data were reported at a hearing of the Senate Committee on Education and Labor on 31 March 1942 by Lieutenant Colonel Joseph Hamilton McNinch on behalf of the Surgeon General.

PREVENTIVE MEDICINE IN THE SECOND WORLD WAR

It is of course too early to evaluate the work of the Army Medical Department in the Second World War. Some of the new measures that have been adopted and some of the work of individuals may prove of lasting benefit to man. A brief mention of preventive measures put into effect during the years 1941 and 1942 (to date) by the *Circulars* issued from time to time from the Surgeon General's Office is worth while.

Immunization against Yellow Fever: On 6 February 1941, it was directed that all personnel of the War Department stationed in the tropics or about to leave for such service be given the yellow fever prophylaxis. On 12 February 1942, it was further ordered that all military personnel, regardless of place of present service, be given such prophylaxis. By an arrangement with the Rockefeller Institute the vaccine, a special strain of living yellow fever virus, attenuated through prolonged cultivation in tissue cultures, is made in their laboratories.

Immunization against Tetanus: On 16 April 1941, it was ordered that all military personnel be immunized and reimmunized with tetanus toxin. Supplementary instructions on 10 November 1941, pertained to immunization of persons found to be hypersensitive. The metal identification tag, worn by each person in the military service, is stamped to show the date that the immunization has been completed. These instructions do not

change the requirement that all persons wounded be given tetanus antitoxin.

Immunization against Typhus Fever: On 14 January 1942, it was required that all military personnel stationed in or travelling through Asia, Africa, continental Europe, or other places where there may be danger from typhus fever be immunized. The immunizing agent is a suspension of killed, louse-borne epidemic typhus rickettsiae prepared by the Cox yolk-sac method. Reïmmunization every four to six months is required as long as the danger of infection persists.

Immunization against Cholera: On 14 January 1942, it was required that all military personnel stationed in or travelling through Asia or other regions where cholera is known to exist, be immunized. The vaccine consists of a suspension of 8000 million killed cholera vibrios (*Vibrio choleræ*) per cubic centimetre. Reimmunization is required every four to six months as long as serious danger of infection is present.

Immunization against Plague: On 14 January 1942, it was required that all military personnel "under serious threat of exposure to epidemics of human bubonic or pulmonic plague" be immunized. The immunizing agent is a suspension of 2000 million killed plague bacilli per cubic centimetre. Reimmunization is required whenever the situation warrants.

Each Soldier to Carry Sulfanilamide. On 9 February 1942, it was ordered that each individual in the military service carry twelve sulfanilamide tablets, U.S.P. (0.5 grammes each) in the pouch containing the first-aid packet. Medical officers were directed to explain the use of these tablets to the men, in the same way that each is instructed in the use of the sterile first-aid dressing in case he is wounded.

Blood Type to be Indicated on Identification Tag: On 22 May 1941, it was ordered that each individual's metal identification tag, required to be worn at all times, be stamped with the blood type, according to the International (Landsteiner) Classification. This should save much time should transfusion become necessary.

CHIEFS OF OTHER BRANCHES OF THE ARMY

Not only have medical officers of the United States Army directed their own activities; it has sometimes happened that one of their number has been selected to head an entirely different branch of the service. While it may not at first sight come within the scope of this paper to consider such men and their work, it really is pertinent, since their background and experience were what qualified them for such assignments. The following are listed alphabetically.

Fred Crayton Ainsworth (1852–1934), Major-General and Adjutant General of the Army, 1904–1912. A native of Vermont, and educated at the University of New York, he was commissioned Assistant Surgeon, 1874. He was promoted through the grades to Major Surgeon, 1891. He early developed a reputation for organization and for the handling of medical records growing out of the late war. In 1886 the Surgeon General had put him in charge of the medical records. The Secretary of War realizing the need for his type of organizing ability, appointed him Colonel and Chief of the Record and Pension Office, 1892. In four months he swept away the arrears of business, amounting, he said, to 10,000 investigations of soldiers' claims. Still more important was his system of preserving valuable papers and of discarding those worthless. Ainsworth's classification, use of jackets etc. are still in vogue. In 1899 he was promoted Brigadier-General and in 1904 he was made Major-General and Military Secretary, the title of the office being changed in 1907 to Adjutant General of the Army. He retired from the office in 1912. In his will he left funds for a library of medical history at the Army Medical Center. Ainsworth was Adjutant General of the Army at the same time that Leonard Wood was Chief of Staff. No love was lost between these two former military surgeons and their disagreements have been called a war of Titans, for both were able strong-willed men.

Frederick Wegener Boschen (1876–1942), Major-General and Chief of Finance, 1936–1940, should be included in this list as a former enlisted man of the Medical Department, though he rendered no commissioned service in that branch. Young Boschen, a native of Brooklyn, enlisted in the Regular Army in the Hospital Corps, as enlisted men of the Medical Department were then called, on 21 August 1898. He had previously served during the Spanish-American war in that same year in a New York Militia regiment. He was advanced through the grades of Acting Hospital Steward, Hospital Steward and Sergeant, First Class, in the Hospital Corps, attaining the latter grade in 1903. In that year he was commissioned Second Lieutenant of Infantry. He had attained

the rank of Major by the time of the World War and in 1920 transferred to the Finance Department. He became Colonel in that branch in 1934 and on 23 April 1936 was appointed Chief of Finance, with the rank of Major-General. He retired on 31 March 1940. He was decorated by the United States with the Silver Star and the Purple Heart and was made a Chevalier of the Legion of Honor by France. He also held the French Croix de Guerre with palms and gold star and the Belgian Military Medal.

William Eustis (1753–1825) of Massachusetts, Secretary of War, 1809–1813. A native of Cambridge, Massachusetts, he was educated at the Boston Latin School and Harvard. He was appointed Surgeon of Gridley's Regiment of Massachusetts Artillery, 1775, in the same year being transferred to Knox's Regiment. In 1780 he was commissioned Hospital Physician and Surgeon, and served as such to the end of the war. He was a member of the Massachusetts General Court, 1788–1794. In 1800 he defeated John Quincy Adams for Congress and served for two terms. In 1807 President Jefferson named him Secretary of War and he continued in this same post into Madison's administration. He was in charge of military affairs in the critical period leading up to the War of 1812. In 1814 President Madison appointed him Minister to Holland, where he spent four years. He sat in Congress again, 1820–1823, in which last year he was elected Governor of Massachusetts. He was President of the Massachusetts Society of the Cincinnati, of which he was an original member.

Harry Lorenzo Gilchrist (1870–) of Iowa, Major-General and Chief of the Chemical Warfare Service, (1929–1933). Entered the military service as Assistant Surgeon, 1898, in time to serve in the Spanish-American War. Was Chief Health Officer of Manila, 1900–1901. Honor Graduate and Hoff Medalist of the Army Medical School, 1903. Had charge of Field Hospital No. 1 sent to San Francisco at time of the earthquake and fire of 1906. Commanded Base Hospital No. 9, the first unit of any branch of the U. S. Army to reach Europe in the first World War. Organized and directed the medical work of the Chemical Warfare Service in the American Expeditionary Forces. Director of the campaign against typhus fever in Poland, 1919, for which service was awarded the Distinguished Service Medal. Directed the Medical Laboratory of the Chemical Warfare Service after the World War and in 1929 was selected to be Chief of that Service. Held the assignment until retired for age. Was editor of *The Military Surgeon*, 1935–1940. Now lives in Washington.

James McHenry (1753–1816) of Pennsylvania, Secretary of War, 1796–1800. Born in county Antrim, Ireland, he came to America in 1771 with the Ulstermen who settled in Philadelphia. Studied medicine at the University of Pennsylvania under the future Surgeon General Benjamin Rush. Volunteering early in the Revolution, he was first assigned to the military hospital at Cambridge, Massachusetts. In 1776 he was appointed Surgeon of the Fifth Pennsylvania Regiment, Continental Line. He was captured at the fall of Fort Washington but was paroled in January 1777 and exchanged in the following year. For a short time he acted as Senior Surgeon of the Flying Hospital, Valley Forge. On 15 May 1778 was appointed Secretary to General Washington. He was transferred to LaFayette's staff, 1780. He was commissioned Major in the Continental Army, 1780, and saw active service to the end of the war. From 1781 to 1786 he was a member of the Maryland Senate, during a part of which time he was also a member of the Continental Congress. In 1784 he wrote *Observations Relative to a Commercial Treaty with Great Britain.* In 1787 he was a member of the Convention which drafted the Federal Constitution. His private record of what transpired is one of the few valuable records thereof, as the official minutes were ordered destroyed. He was appointed Secretary of War in 1796 in Washington's cabinet and retained the portfolio into Adams's administration, but resigned in 1800. Fort McHenry, near Baltimore, was named in his honor and when the battle occurred there in the War of 1812 which gave us our National Anthem, the Star Spangled Banner, his son volunteered for the defense.

Edward Lyman Munson (1868–) of Connecticut, Brigadier-General and Chief of the Morale Branch of the General Staff, (1918–1922). Served for a short time in 1893 in the Medical Corps of the Navy, following his graduation in arts and medicine at Yale. Commissioned Assistant Surgeon, U. S. Army, 1893. Participated in the Cuban campaign in the Spanish-American War, returning to the United States in charge of the wounded on hospital transports. Published *Theory and Practice of Military Hygiene*, 1901, long a

standard work in the American and British services. Appointed Health Officer of the Philippines, 1903. Professor of Military Hygiene at the Army Service Schools, Ft. Leavenworth, 1908. Published *A Study in Troop Leading* (1910), *The Soldier's Foot and Shoe* (1911), and *Principles of Sanitary Tactics* (1912), all three adopted by the Army. The "Munson last" described in his book is still the Army's standard and also widely used generally. Editor of *The Military Surgeon* (1916–1918). In charge of the Training Division of Surgeon General Gorgas's office at the outset of the World War. Commanded Camp Greenleaf, Georgia, training center for medical personnel. Appointed Chief of the Morale Branch of the General Staff, 1918, and served as such to the end of the war, winning the Distinguished Service Medal for his work, as well as the Order of the Bath from King George V. Subsequently held such important assignments as Chief Surgeon of the Philippine Department, Corps Area Surgeon, San Francisco, and Commandant of the Medical Field Service School at Carlisle Barracks, Pennsylvania. Has made noteworthy contributions to ornithology and climatology. Lives in New Haven, Connecticut.

Albert James Myer (1828–1880) of New York, Brigadier-General and first Chief Signal Officer of the U. S. Army, (1863–1880). Graduating in medicine at the University of Buffalo in 1851, was commissioned Assistant Surgeon in the Army in 1854. Served successively at Fort Wood, New York Harbor, Fort Duncan, Texas, and elsewhere in what used to be called "the Indian country." Became interested in the Indians' system of beacon lights and smoke signals, a result of which was his system of signalling being adopted by the Army, and which was of the utmost use during the War Between the States. This led to his appointmet in 1860 as Major and Chief Signal Officer. He served as such to the end of the war. He was later given the rank of Brigadier-General and is the father of the Signal Corps of the Army today. Fort Myer, Virginia, is named in his honor. He trained medical officers in meteorological work and in climatology. He is regarded as the founder of the Weather Bureau and devised many of its practices still in use, such as *Farmers' Bulletins*, weather signals and reports, and the like.

Leonard Wood (1860–1927) of New Hampshire, Major-General and Chief of Staff of the Army (1910–1914), after completing his medical education at Harvard, entered the Army as Assistant Surgeon, 1886. Within a year he won the Congressional Medal of Honor for extreme bravery in the campaign against the Apaches under Geronimo. Promoted Captain Assistant Surgeon, in 1891. In 1897 made the friendship of Governor Theodore Roosevelt. In the following year, at the outbreak of the War with Spain, Wood was appointed Colonel and Roosevelt Lieutenant-Colonel of the First United States Volunteer Cavalry ("Rough Riders") and won distinction in Cuba. In 1899 appointed Military Governor of Cuba. Was in charge at the time of Walter Reed's work and gave him every support. Appointed Governor of the Moro Province, Philippine Islands, 1903, having risen to the grade of Major-General. Appointed Chief of Staff of the Army in 1910. Was the father of the "Plattsburgh Idea," i. e., the training of volunteer officers for military duties, that at a time when Congress had not authorized a reserve in any branch of the Army except the Medical Department. Commanded a division in the World War. Unsuccessful candidate for the Republican nomination for president in 1916.[50]

THE U. S. ARMY BOARD FOR THE STUDY OF TROPICAL DISEASES

With the taking over of the tropical possessions after the Spanish-American War many new problems had to be solved by the Medical Department of the Army. Such problems were particularly difficult in the Philippines. To help the authorities in making decisions, Surgeon General Sternberg, with his usual vision, created a Board for the Study of Tropical Diseases. The members of this Board were First Lieutenant Assistant Surgeons Richard Pearson Strong (later Colonel), William Jeptha Calvert, Acting Assistant Surgeon Joseph J. Curry and Dr. William Everett Musgrave, Hospital Steward. The board's work was soon of the greatest value. They studied chiefly plague, cholera, dysentery, typhoid fever, smallpox, etc.

As the years went on the Board continued its

[50] In our neighbor, Canada, there is a recent instance of a career not unlike that of General Wood. Lieutenant-General Ernest Charles Ashton, C.B., C.M.G., V.D., a physician, has held the highest offices in the Canadian Army. He has been, in turn, Adjutant General, Quartermaster General, Commander of Military District No. 2 and Military District No. 11, and from 1934 to 1937 Chief of the General Staff. He, however, was never a member of the Royal Canadian Army Medical Corps. He served in France in the first World War in command of a brigade of infantry.

work. In 1909, upon the recommendation of its two members, Captain (now Colonel, retired) James Matthew Phalen and Captain Henry James Nichols (1877–1927), the diet of Filipino scouts was changed, with a reduction in the incidence of beri-beri. In 1910 Colonel (then Major) Eugene Randolph Whitmore established the Pasteur Institute in Manila.

There is not space to consider fully the many diseases and problems studied. During the years 1908–1910, for instance, the board did work on a number of tropical diseases that were only slightly known in the United States, including paragonimiasis, schistosomiasis, filariasis, amœbiasis, oïdiomycosis, yaws, blastomycosis, sprue, ainhum, cholera, trypanosomiasis, and dysentery. Some of these are mentioned elsewhere in this account. The Board likewise studied uncineriasis, typhoid fever, tuberculosis and other maladies that were different in their tropical manifestations from the clinical picture known at home.

In Surgeon General Patterson's administration the Tropical Board was transferred from Manila to Panama, where its work has continued. Colonels George Russell Callender, James Stevens Simmons, and others have carried on the excellent traditions already established.

Meleney calls the first two decades of the present century "The Golden Age of Tropical Medicine in the United States," for then yellow fever, malaria, hook-worm infection, typhoid fever and the dysenteries were largely brought under control. Certainly officers of the United States Army Medical Corps did many of the important things to this end (*cf.* Henry E. Meleney, *Tropical Medicine in United States Military History*, *Bulletin of the New York Academy of Medicine*, May, 1942, xviii, 329–337).

MEDICAL OFFICERS PROFESSORS AT UNIVERSITIES

It would be impossible to list all the medical officers of the United States Army who have at some time in their careers, usually after retirement or resignation from active service, been professors of medical subjects in medical schools or other graduate institutions. Some of them may be mentioned.

Surgeon John Jones, author of the first American textbook on surgery, was Professor of Surgery at King's College (now Columbia University). Hospital Surgeon Benjamin Waterhouse was Professor of Medicine at Harvard. Surgeon Generals John Morgan and William Shippen were respectively Professors of Medicine and Surgery at what is now the University of Pennsylvania. Deputy Surgeon General John Shaw Billings, father of the Army Medical Library, was Professor of Hygiene at the University of Pennsylvania, after having been Lecturer in that subject at the Johns Hopkins University. Colonel Richard Pearson Strong, one of the original members of the U. S. Army Board for the Study of Tropical Diseases, became Professor of Tropical Medicine at Harvard. Colonel Charles Franklin Craig, one of the best known of the Army's protozoölogists, became Professor of Tropical Medicine at Tulane University. Brigadier-General Edward Lyman Munson became Professor of Preventive Medicine at the University of California. Colonels Eugene Randolph Whitmore and Edward Bright Vedder became Professors, respectively, at Georgetown University and George Washington University at about the same time. Surgeon General William Alexander Hammond was Professor of Anatomy at the University of Maryland, and later of Nervous and Mental Diseases at the College of Physicians and Surgeons of New York. Surgeon General Robert Urie Patterson is at present Dean of the University of Oklahoma Medical School. Major Walter Reed was Professor at the George Washington University at the same time that he held a chair at the Army Medical School, the same being true of Major (later Brigadier-General) Frederick Fuller Russell, who is now Professor of Preventive Medicine at Harvard. Lieutenant-Colonel William Cline Borden was Professor of Surgery (and Dean) at George Washington University. Colonel Bailey Kelly Ashford, who freed Puerto Rico from hookworm, became head of the School of Tropical Medicine of the University of Puerto Rico, the department working in coöperation with Columbia University, New York. Lieutenant-Colonel Arthur Parker Hitchens is now Professor of Public Health at the University of Pennsylvania. Acting Assistant Surgeon Aristides Agramonte, member of Walter Reed's famous Yellow Fever Board, was Professor of Pathology at the University of Havana until his death. Captain Arthur Carlisle Christie is Professor of Roentgenology at George Washington University.

OTHER PRIORITIES

The Medical Department of the Army has certain other priorities of which it is justly proud. Though

not strictly scientific accomplishments within the meaning of the title of this study, they are worth mentioning, for in most instances they led to advances within the Army.

The Army Medical School, established in 1893 by Surgeon General Sternberg, is the oldest of the Army's service schools. Such schools now exist for each branch of the military service.

The Association of Military Surgeons, founded 17 September, 1891, is the oldest of the Army's associations, of which there is now one for each branch.

The Military Surgeon, the monthly journal of the Association of Military Surgeons, is the oldest scientific journal in the United States Army. It also represents the United States Navy and United States Public Health Service, being older than any scientific publication in either of those services.

The Medical Reserve Service Corps, created by Act of Congress in 1908 upon the recommendation of Major (now Brigadier-General, retired) Jefferson Randolph Kean, was the first reserve of the United States Army during its history of a hundred and twenty years. Surgeon General Robert Maitland O'Reilly (1845–1912) had the vision to see the need of this Corps, and the influence necessary to have the legislation enacted. The National Defense Act, by which Congress created an Officers Reserve Corps, with many branches (including one for medical officers), was passed in 1916. Thus the Medical Department led the way for more than eight years.

In these days our Army has gone in for things heraldic in a large way and every regiment and many other units have arms, duly created by the Quartermaster Corps and approved by higher authority. The oldest coat of arms in the United States Army is that of the Medical Department. It was adopted in 1818.[51]

There are certain other priorities of which the Medical Department is proud. In the World War the first American wounded was a Captain of the Medical Corps. The second was an Army nurse. The first enlisted man killed was of the Medical Department. The first American military unit to reach Europe was a medical one. The last one to leave in 1923 was also a medical unit. The Medical Department's battle death percentages in the World War were higher than those of the Aviation, Cavalry, Engineers, Ordnance, or Quartermaster Corps. Those with higher percentages than we were the Infantry, Signal Corps, Artillery and Tanks. So, though what are termed "non-combatants," we are not far from danger. Remember, that in a withdrawal—and there are some in even the most successful wars—the medical unit is the last to leave, and having advanced with the first lines, is therefore in danger longer than any other branch. Nothing so adds to the morale of the soldier as the knowledge that if wounded he will receive immediate care. The medical officer and medical soldier are there to render that aid, but the fire of the enemy does not discriminate and their chance of being hurt is that of any other soldier.

Besides the things above considered, the Medical Department of our Army has done its regular work well. It has created special schools for training of its personnel, modern hospitals, methods of examining large numbers of men expeditiously, a system for the acquisition and handling of medical supplies, modern camp sanitation, a laboratory for the development of medical equipment, systems for efficient transportation of patients in the field and elsewhere, advanced modern therapeutic measures and surgical techniques, etc. Its officers have organized health services of cities, states and even countries, have aided in preserving the health of civil populations, have made important geographical explorations, have shed their blood on the field of battle and received decorations for extreme gallantry in action and for distinguished service, have coöperated with the Medical Corps of our Navy and with various foreign military services. These are but some of the duties for which our service exists. It expects no special praise for having done them well. It has merely done what was expected of it. But at least this illustrates the truth of a statement by former Surgeon General Ireland, that our medical officers have always kept abreast of medical progress, and often have led the way.

The medical officer of today, like brother officers of all branches of our Army, has a mighty part to play in the defense of our land and of our ideals. He has an immediate task before him; but even amid all this he plans for the future, and the plans that he makes and the dreams that he dreams are not all directly connected with wars and the rumors of wars. When he thinks of what his predecessors have been able to achieve, of what practical good has come of their experiments—amateurish though some of them have been, of the outcome of patient

[51] *The Military Surgeon*, Aug., 1917, xli, 137–148.

observation, of the productive results of the application of scientific principles and sound logic, he is filled with solemn pride and hope, and is heartened to continue his task in the realization that his efforts are not only "for the good of the service," to use a military catch-phrase, but likewise for the good of the whole nation and of all mankind.

We believe that medical officers of the United States Army have by their achievements held their own in comparison with the great medico-military officers of other nations, such as John Hunter, Sir Ronald Ross, Sir William Leishman (sometime director of the British Army Medical Service), von Graefe, Vincent of angina fame (sometime Director of the French Army Medical Service), Helmholtz, Descartes, Cohnheim, Dupuytren, Loeffler, von Behring, Willis, Laveran, Widal, Purmann, Pirogoff, Laennec, Paré, Esmarch, Klebs, Pringle, Larrey, and others.

Perhaps, too, what our branch of the American Army has done compares favorably with the so-called "civil" accomplishments of the army as a whole, such as the digging of the Panama Canal, the construction of early railways, the building of the Capitol, Washington's Monument and Library of Congress in Washington, the Lewis and Clark Expedition to the Northwest Territory, the expedition of Pike (of Pike's Peak), the rivers and harbors work, the conduct of affairs after the San Francisco earthquake, and the rest.

CONCLUSION

In November, 1888, the great Pasteur in closing his address at the inauguration of the Institution which bears his name, said:

"Two opposing laws seem to me now in contest. The one law of blood and death, opening out each day new modes of destruction, forces nations to be always ready for battle. The other, a law of peace, work and health, whose only aim is to deliver man from the calamities which beset him. The one seeks violent conquests, the other the relief of mankind. The one places a single life above victories, the other sacrifices hundreds of thousands of lives. The law of which we are the instruments strives even through the carnage to cure wounds due to the law of war. Treatment by our antiseptic methods may preserve the lives of thousands of soldiers. Which of these two laws will prevail, only God knows. But of this we may be sure, that science, in obeying the law of humanity, will always labor to enlarge the frontiers of life."

The Medical Department of the United States Army has ever striven to "enlarge the frontiers of life." While carrying on the duties devolving on it as a branch of our military establishment, it has found time to add greatly to the sum of science's learning. Its officers go ever on and on toward a noble goal, illuminated by the bright light that has been shed by the brilliant genius of our great ones.

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Tuberculosis Control

Col. Bushnell's theories and studies of tuberculosis are cited above; cf. particularly *Immunity through*

Tuberculosis Infection, in *The Military Surgeon*, 1913. A study of the Army's contributions to tuberculosis control and the work now being done in Pennsylvania by former Surgeon General Reynolds is described in his *Tuberculosis and Military Medicine* in *Medical Clinics of North America*, November, 1941. Gen. Gilchrist's analysis of the correlation between injury by warfare chemicals and tuberculosis is cited above. Col. George R. Callender's *Tuberculosis in Filipino Troops*, written with Major Shepard and Capt. Kirkwood, is in *The Military Surgeon*, May, 1925, and later in the *Philippine Journal of Science*. For account of the Army's Sanitarium at Fort Bayard, see *The General Hospital and Sanatorium for Treatment of Pulmonary Tuberculosis* at Fort Bayard, New Mex., by Major Daniel M. Appel, *The Military Surgeon*, 1902.

First American Textbook on Surgery

A consideration of Surgeon John Jones's work is given in J. B. Beck's *Historical Sketch of the State of American Medicine Before the Revolution* (1842). See also Jones's biography in the *Dictionary of American Biography*.

Surgery of Gunshot Wounds

The Surgical volumes of the *Medical and Surgical History of the Rebellion* include Brinton's work on gunshot wounds. The epoch making *Gunshot Wounds and other Injuries of Nerves* by Mitchell, Morehouse and Keen (1864) and its revision *Injuries of Nerves and their Consequences* (1872) are full of valuable information. Colonel LaGarde's many works are cited in the text. *The Medical Department of the United States Army in the World War* includes two large volumes (XI parts 1 and 2) on Surgery.

Forensic Ballistics

Col. Goddard's work is cited in the text, as is also that of Col. Callender and others.

Thoracic Surgery

Colonel Keller's papers on his thoracic surgery are listed in the *Index Catalogue* and *the Index Medicus*. Volume XI, part 2, of *The Medical Department of the United States Army in the World War* gives a full report on surgery following empyema.

Field Surgery

An account of Surgeon Letterman's work is given in the sketch of him by B. A. Clements in the *Journal of the Military Service Institution*, 1883, and in *Review of the Life and Work of Jonathan Letterman* by J. T. Smith, *Johns Hopkins Hospital Bulletin*, August, 1916.

Plague

The work of the Tropical Board on Plague in Manila is set forth in Circular No. 1, issued there in 1901, also reviewed by J. J. Curry, *Report on the Plague in Manila*, *Boston Medical and Surgical Journal*, 1901. Gen. Edward L. Munson's paper *The Movement of Plague in the Philippine Islands*, published in 1904 in the *Medical Record*, gives additional information.

Pneumonia Prevention

Aside from the references in the text see *The Medical Department of the United States Army in the World War*, Volume IX, *Communicable and Other Diseases*, and Volume XII, *Pathology of the Acute Respiratory Diseases*.

Trench Fever

A complete account of the American Commission's work is given in the monograph *Trench Fever* (1918).

First American Pharmacopœia

For a biography of Physician General Brown, see J. M. Toner's *Medical Men of the Revolution* (1876) and Col. Louis C. Duncan's book of the same title (1931). Bessie W. Gahn, a descendant of Brown, wrote of him in *The Military Surgeon*, 1926, and in the *Journal of the American Pharmaceutical Association*, 1927. The first Pharmacopœia has been published in *facsimile* by the American Pharmaceutical Association.

Malta Fever

Victor C. Vaughan's *Epidemiology and Public Health* (1923) gives a good history of this disease, including the work by U. S. Army medical officers. Col. Gentry's work is given in his *Undulant Fever* (Oxford Press, 1930). The Army's contributions are briefly set forth in *Observations on Malta Fever in the United States Army* by First Lieutenant (now Colonel, retired) Charles F. Craig, *The Military Surgeon*, 1904.

Cholera and Dysentery

The subject is reviewed in Col. Percy M. Ashburn's *The History of the Medical Department of the United States Army* (1929). The Army's campaign against these diseases prior to the Spanish-American War is discussed by Col. Joseph J. Woodward in his *Address on the Medical Staff of the United States Army and its Scientific Work* in the *Transactions of the International Medical Congress of Philadelphia*, 1876.

Dengue

The instructions of Surgeon General O'Reilly to the Tropical Board to study dengue are given in the *Annual Reports of the Surgeon General for* 1906 and 1907. The monograph on the studies that demonstrated that *Aëdes ægypti* is the vector is *Dengue* by Siler, Hall and Hitchens (Manila, 1926), the subject being reviewed by them in the *Journal of the American Medical Association*, 18 April 1925 and *The Military Surgeon*, January 1926. The subject is brought down to September,

1931 in *The Military Surgeon* by Col. James Stevens Simmons.

Alcoholism

The *Annual Report* of Surgeon General Lovell gives his recommendation that the rum ration be abolished. Billings's studies, 1894, are in the report of *The Committee of Fifty for the Investigation of the Liquor Problem*, which he wrote.

Medical History

The publications mentioned above tell their own story.

Sandfly Fever and other Fevers of Short Duration

The complete bibliography of Sandfly-fever is in Edgar Erskine Hume's chapter on that subject in *Tice's Practice of Medicine*, 1925, second edition, 1939. Other references are in the text.

Anthropology and Ethnology

For sketch of Colonel Woodruff see the *New York Times* for 15 June 1915; also editorial in the same issue. Other obituaries printed at the time of his death are in the *Lancet-Clinic*, *Medical Record*, and the *New York Medical Journal*. Shufeldt's articles, duly listed in the *Index Catalogue*, are also recorded in his *Complete List of my Published Writings with Brief Biographical Notes*, in nine installments in the *Medical Review of Reviews*, 1920. See also Edgar Erskine Hume's *Ornithologists of the U. S. Army Medical Corps* (1942), for biographies of Coues, Yarrow and Shufeldt.

Contributions to Neuropsychiatry

The references in the text are complete. The *Annual Reports of the Surgeon General* to the Secretary of War contain many data.

Study of the Effects of Ultraviolet Light

Col. Woodruff's many publications are cited in the text. See also the sketch of his life in the *Dictionary of American Biography*.

Defense against Warfare Gases

Col. Vedder's *The Medical Aspects of Chemical Warfare* (1925) contains a good account of early work with full references. The text lists many of the articles by General Gilchrist. Colonel Fleming, director of the Medical Research Laboratory at Edgewood Arsenal, home of the Chemical Warfare School, has kindly given further information. Since much of the work being done is confidential, it cannot be cited for the present.

Study of the Human Foot and its Proper Shoe

General Munson's book *The Soldier's Foot and the Military Shoe* (1917) gives the story. The later study by Colonel Weed is mentioned in the text with reference.

Jamaica Ginger Paralysis

The article by Edgar Erskine Hume in *The Military Surgeon* for November, 1930, gives full bibliography.

Study of Dental Focal Infection

The statistical data are from the *Military Medical Manual* (3rd edition, 1940), 363. General Fairbank's address at the Mayo Clinic is in *The Military Surgeon* for January, 1939.

Bacteriology of Dental Caries

Major Rodriguez's work is reported in *The Military Dental Journal*, 1921 and 1922, with later account in the *Journal of the American Dental Association*, 1930.

Diseases Transmissible from Animals to Man

Brigadier-General Kelser has kindly summarized his work at the author's request, and his statement has been quoted at length. Specific references to Kelser's work are: *A New Vaccine for Rinderpest Immunization*, *The Military Surgeon*, July, 1927; *An Improved Rinderpest Vaccine*, *Proceedings of the Far Eastern Association of Tropical Medicine*, Calcutta, 1927; *An Improved Vaccine for Immunization Against Rinderpest*, *Philippine Journal of Science*, August, 1928; *The Treatment of Surra among Animals of the Equine Species*, *ibid.*, October, 1927; *Chloroform-Treated Rabies Vaccine*, *Army Veterinary Bulletin*, 1928, xxii; also *Journal of the American Veterinary Medical Association*, November, 1930, lxxvii; *Mosquitoes as Vectors of the Virus of Equine Encephalitis*, *ibid.*, May, 1933, lxxxii; *Transmission of the Virus of Equine Encephalomyelitis by* Aëdes Tæniorhynchus, *ibid.*, February, 1938, xcii; *Osteomalacia*, *Philippine Journal of Science*, September, 1932, xlix; *Preparation of Antigen for the Complement-fixation Test for Dourine*, *Journal of Agricultural Research*, 1918, xiv. *Veterinary Military History of the United States* by Lieutenant-Colonels Louis A. Merillat and Delwin M. Campbell (1935) gives much valuable general information.

Nursing in the Army

For a review of the history of nurses in our Army, see the *Annual Report* of the Surgeon General for 1899 (transcribed in Ashburn's *History of the Medical Department of the United States Army*) and the comprehensive monograph by Major Julia C. Stimson, Superintendent of the Army Nurse Corps, *Army Medical Bulletin* No. 41, October, 1937. The study *Women Nurses in the American Army* by Acting Assistant Surgeon Anita N. McGee, Superintendent of Nurses, *The Military Surgeon*, 1899, gives the picture at the time of the Spanish-American War. Her *The Nurse Corps of the Army* (*ibid.*, 1902) tells of the creation of the Nurse Corps. *Women Nurses with the Union*

Forces During the Civil War, by Major Julia C. Stimson and Ethel C. S. Thompson is in *The Military Surgeon*, January, 1928.

Preventive Medicine for the Civilian Conservation Corps

The *Military Medical Manual* (3rd edition, 1940), 355 *et seq.*, mentions some of the work done by the Army for the Civilian Conservation Corps. Other statistics are quoted in the *Congressional Record* for 18 March 1936, based on data supplied by the Surgeon General's Office.

Preventive Medicine in the Second World War

The text cites the actual orders of the Surgeon General putting certain administrative measures into effect.

Chiefs of Other Branches

Brief biographic sketches are found in the *Dictionary of American Biography*, which gives bibliographic references, and in *Who's Who in America*. Sketches of Secretaries of War Eustis and McHenry are in J. E. Pilcher's *Surgeon Generals of the Army* (1905). Biographies of Generals Wood and Munson are in Edgar Erskine Hume's *Ornithologists of the U. S. Army Medical Corps* (1942). Sketches of Generals Myer and Gilchrist are in *The Military Surgeon* for 1930 and 1941. A biography of Gen. Ainsworth is in the *Journal of the American Military History Foundation*, 1938.

Board for the Study of Tropical Diseases

The work of the Board is given in its successive annual reports, abstracted in the *Annual Reports of the Surgeon General*. Its studies have been considered by various members and published in *The Military Surgeon* for 1908, 1910, 1911, and 1930. A general consideration by Captain Percy M. Ashburn and First Lieutenant Charles F. Craig (both later Colonels) is *Tropical Disease in the Philippine Islands*, *The Military Surgeon*, 1907.

Rummaging in the Museum
II*
The Petrified Lady

By JOSEPH McFARLAND, M.D.

Curator of the Mütter Museum, and Fellow, of the College of Physicians of Philadelphia

AMONG the numerous and remarkable possessions and a leading exhibit of our Mütter Museum is an adipocere body commonly spoken of as the "Petrified Lady."

Just inside the door of the innermost room of the lower floor, she lies in a coffin-like case as though laid out for what the morticians now speak of as "viewing," but although there is perfect quiet and dim lighting, there are no surrounding clusters of flowers to give off their funereal sweetness, no friends and relatives to whisper in the background, and no undertakers in solemn black silently flitting to and fro. No, it is not a funeral but an exhibition, for her body, buried long ago became changed to adipocere, and thus has become an object of rare scientific interest.

A petrified lady! What does one expect? Youth and beauty richly clad to await a glorious eternity? If so, prepare for disappointment for the case contains one of the most revolting objects that can be imagined. The body seems to have been buried without an undertaker's skill, or even the friendly ministrations of some unprofessional hand, for it is nude, the jaw has fallen, and the toothless mouth gapes widely open.

The whole body is black from the dust that has accumulated in a half century—even in a closed case—and which it is impossible to remove because of the adhesive and crumbling nature of the surface to which it is attached. All that remains is a mass of dirty, wrinkled, cracked and crumbling waxy substance shaped in conformity to a human figure.

Few anatomical land-marks remain, but the breasts, once prominent, are as in old age, now flattened against the chest wall. They, and the long thin hair tied with a ribbon, are all that remain to determine the sex.

The features are not easily made out, but the open mouth is unmistakable and it is without a single tooth.

Evidently our lady had a plump figure and full breasts, but was old, and probably ugly, with a nut-cracker profile at the time of her death.

Let us read what the label says:

> "*Mutter Museum* #13000.
> Body of a fat woman changed to adipocere; 'Petrified Body.' The woman, named Ellenbogen, died in Philadelphia, of yellow fever in 1792 and was buried near Fourth and Race Streets. The process of change is as follows:—The nitrogenous tissues give off ammonia, this attacking the fat of the body forms a hard soap. The form is well preserved.
> Presented by Dr. Joseph Leidy."

This brief statement evidently satisfies most of our visitors, but it raises a lot of questions: Why does not a similar change take place in the bodies of all fat people? What may yellow fever have had to do with it in this case? What did telluric conditions have to do with it? Were other yellow fever victims similarly affected? Were other corpses interned near Fourth and Race Streets similarly affected? Had these questions occurred to Doctor Leidy and had he published an account of this case?

We remember another "petrified body"—another adipocere body—with which we became acquainted during student days. It then occupied a prominent place in the Wistar and Horner Museum of the Medical Department of the University of Pennsylvania, then housed in the Logan Hall, but now lies in the museum of the Wistar Institute. It's label says:

> "4249 Wistar Museum
> Body of Wilhelm von Ellenbogen, who died of yellow fever in 1792 aged 63 years.
> The fat is converted into adipocere, an ammonical soap. A so-called petrified body.
> Presented by Dr. Joseph Leidy."

* "A Resurrection of 'Pile': the Peter A. Browne Collection of Hair in the Mütter Museum" (*Transactions & Studies*, December, 1939) is to be regarded as the first article in this series.

So our "Petrified Lady," and the Wistar Institute's "Petrified Man" had the same name and died of the same disease, in the same city, in the same year. From the little that remains to judge by, the two must have been pretty nearly of the same age, that is, in the sixties. Could they have been husband and wife or brother and sister? Who were they? What were they?

We carefully examined all of the old catalogues, old letters, and other documents in the Mütter Museum, and securing the coöperation of Doctor Farris, the director, had a similar search carried out in the Wistar Institute, but nothing was found that gave the slightest information about the people.

However, one document of great importance was found in the Mütter archives, of which more will be said later.

You may have noticed that the names are not exactly the same: the man in the Wistar Institute was Wilhelm *von* Ellenbogen, the woman in the Mütter Museum, simply Ellenbogen. In Germany that little word *von* signifies of a noble family.

Were these people of the German nobility? If so, what were they doing in Philadelphia in 1792? Were they residents or were they tourists, who, while visiting our city, were fatally stricken with the loathsome disease and hurried into some hastily prepared grave with no friends or relatives to attend with the conventional funereal pomp and ceremony? Could that have happened in 1792? There was no yellow fever in Philadelphia in that year, the great epidemic having begun in the summer of 1793.

Ellenbogen! Where did we hear that name before? Ah yes, sailing down the Rhine River and enjoying its wealth of beauty and romance, we passed two ruined castles, one "die Maus" and the other "die Katz." Baedeker's Guide book explains these odd names thus. The Turnberg or Deurenberg, the smaller castle, was the stronghold of Archbishop Behmund II of Treves. It was derisively called the *mouse* by the family of Count Johann Katzenelnbogen, who called their own larger castle the *cat*. Allowing for a difference in the spelling, could our Wilhelm von Ellenbogen be one of that family? Apparently not, for Baedeker also says that the family became extinct in 1470.

As von Ellenbogen must be the name of a once noble family it was suggested to me that Wilhelm von Ellenbogen may have come to this country as an officer of some of the Hessians and other German mercenaries hired by the British to help them in the revolt of the colonies. But if so, what was his wife or sister doing here? Did she come along with him or afterward?

It should not be difficult to answer this question as J. S. Rosengarten has published a translation of Elking's "List of the German Allied Troops in the North American War of Independence 1776–1783," in which appear the names of both officers and privates of all of their organizations. All of the lists were carefully gone over but no Katzenelnbogen, von Ellenbogen or Ellenbogen was found among them.

Shorberger and Hinke have compiled a long list of "Pennsylvania German Pioneers," a somewhat discouraging writing for the purpose we are pursuing, but taking plenty of time, we went through the lists of all of the ships and their passengers up to 1794 without finding a single one named Ellenbogen!

Another publication—J. S. Rupp's "Thirty Thousand Names of German, Swiss, Dutch, French and Portugese Immigrants"—alphabetically arranged, was soon disposed of. None of the names—Katzenelnbogen, von Ellenbogen or Ellenbogen—appears. It seems strange that these petrified people should not have been known. Where did they live in Philadelphia before their illness and death?

The first "Philadelphia Directory" was published in 1791. We examined it hopefully, but were again disappointed. None of the names appeared in 1791 or 1792 or 1793.

Were there ever any Ellenbogens in Philadelphia, we ask, in perplexity, and go on through the directories until at last we are rewarded. The name Ellenbogen first appears in a "Philadelphia Directory" in 1836. Only two people are so named, and it is curious that in the latest edition of a "Philadelphia City Directory," 1935–6, there were still only two persons of that name, and only two appear in the latest issue of the "Philadelphia Telephone Directory, 1941."

A letter of inquiry was written to each of them, and it was learned that they were cousins, but neither of them knew of any Philadelphia ancestors. The family from which they are descended seems to have belonged to the "Country Dutch" who lived in the neighborhood of Danville, Pennsylvania.

The paradox of having the dead bodies of two

people who never seem to have been alive excited us to further investigation.

In 1892 William Henry Egle published a list of "The Names of Foreigners who took the Oath of Allegiance to the Province and State of Pennsylvania." We turned its pages eagerly but no Katzenelnbogens, von Ellenbogens or Ellenbogens are there.

The labels in both museums say that they died of yellow fever in 1792 and we remembered that Matthew Carey in his "Short Account of the Malignant Fever Prevalent in Philadelphia, etc.," had published lists of the 10,000 people who died of yellow fever in 1793. Imagining that there might have been an error in transcription and that 1793 was meant, we went through them all, as well as the lists of those who were admitted to the temporary hospital at Bush Hill, but in none do the names appear.

Carey also published a list of the interments made in the various cemeteries of Philadelphia, through which we also looked with no success.

Another line of investigation was suggested by the label in the Mütter Museum which says "was buried near Fourth and Race Streets."

In 1792 burials were made largely in churchyards or near-by. Thus the first burials at Christ Church were in the churchyard, then later in the cemetery at 5th and Arch Streets, where Benjamin Franklin is buried. What church was at or near Fourth and Race Streets in 1792? We referred to Scharf and Westcott's "History of Philadelphia," and soon received the impression that the neighborhood of Fourth and Race was one of the most religious and best churched in the city. There were three churches within a block of one another.

The Ellenbogens, being German, would almost certainly have been members of some German church, and probably have been buried in its cemetery.

All three churches in the blocks at Fourth and Race Streets were German. The oldest was the German Calvinist or "Reformed" Church, a small quaint hexagonal stone building that stood on the south side of Race Street at the corner of Sterling Alley (between 3rd and 4th Streets). Around the corner, on Fourth at Cherry Street was the Zion Lutheran Church, one of the finest in Philadelphia, with the largest and best organ in America. The third was St. Michael's Lutheran Church which stood on Race above Fifth Street. They are all gone now, and nothing remains to suggest that they were ever there.

We began our investigation with the oldest, the Reformed Church, whose descendants now occupy a new stone building at the corner of 50th and Locust Streets in West Philadelphia. Through the kindness of Mr. Charles Hummel, an official of the church, I have learned two things of interest; first, that the records reveal no members named Ellenbogen and second, that the church cemetery in which they might have been buried was not at the church, but in North East (now Franklin) Square, three blocks away.

From a pamphlet entitled "The Old First Church, Evangelical and Reformed," and one of its paragraphs, "Historical Milestones of the First Church," the following is learned:—"On December 6th, 1747, a quaint hexagonal structure with a cupola was dedicated. This was on Sassafras Street (now Race Street), near Fourth. Other buildings, much larger were built on the same site in 1774 and in 1837. The latter building still stands housing the warehouse of the Lucas Paint Company."

From 1882 to 1915 the congregation occupied a building at 10th and Wallace Streets, and in 1915 moved to West Philadelphia, the present beautiful stone church having been dedicated in 1925.

Concerning the Zion Lutheran Church, it has been moved to the west side of Franklin Square between Race and Vine Streets. But it also had its cemetery apart from the church property, in the square bounded by Race, Vine, Franklin and Eighth Streets.

The discovery that the cemeteries of these churches were not at Fourth and Race Streets, but some blocks away, seemed to make it necessary to try a new line of investigation.

An amusing legend about Professor Joseph Leidy and the body of Wilhelm von Ellenbogen was current when I began to study medicine, and I probably first heard it in the autumn of 1885. It was an amusing story and I have told it time after time for a half century, each time probably making small additions and subtractions to increase its artistic merit as well as its interest. Here it is:

Dr. Leidy being informed that the widening of a street had necessitated the exhumation of some bodies buried in a certain cemetery, and that some of them were petrified, hurried to the scene, found that the information was correct, and that some of

the bodies had transformed to adipocere. They were attractive specimens and he at once thought of the two museums in which he was particularly interested. He therefore began by approaching the contractor, whom he asked how he might obtain two of the best specimens for that purpose.

Here is where poetic license comes in to make a good story:

Dr. Leidy: "Petrified bodies like these are of great scientific interest, and I am wondering whether I could have two of them, one for the University and one for the College of Physicians."

Irish Contractor, with the outward appearance of righteous indignation but with a twinkle in his eye: "Could ye hev two uv thim bodies? Now ain't that a nice question to ask. Thim people has relatives that is lookin' after thim and pay me for removin' 'em. Do ye think I could go back on thim? Ye ought to be ashamed uv yerself to be temptin' me like that."

(Then as an after thought) "But uv course if ye was to git en order for me to deliver thim to you, there's nothing else I could do. I'll lay thim aside a while for ye."

Dr. Leidy took the cue. Retiring to the nearest drug store he secured paper and pen and wrote a letter which he gave to a man with a horse and wagon, directing him to deliver it to the contractor at the excavation. It said: "Deliver to the bearer of this order, the bodies of my deceased aunt and uncle about which I spoke to you a while ago."

Rumor said that a substantial bank-note was enclosed so that the deal was successfully consummated.

In recent years I have had this story repeated to me so nearly in my own language, that I almost came to believe that I had invented it. However, I have a letter from Dr. Guy Hinsdale, former curator of this museum, in which he says that he had the story "*from Dr. Leidy's own lips.*"

But those who know the story express some difference of opinion as to the whereabouts of the excavation. I believed it to have been on Broad Street below Chestnut Street, where the Lafayette Hotel once stood, on the ground now occupied by the Land Title Building; Dr. Hinsdale thinks it was in the neighborhood of Third and Pine Streets; the museum label says "the neighborhood of Fourth and Race Streets."

This brings us to the point where I recall to your minds that in the early part of this account I said that only one document referring to the Petrified Lady was found in the archives of the museum. It is a receipt for money paid for the specimen and reads as follows:—

"Nov. 18th, 1875.
Museum of the College of Physicians.
Dr.
To Dr. Joseph Leidy
Expenses on the procural of an adipocere body $7.50.
Received payment
Joseph Leidy."

That surely is corroborative of a part of the legend at least, but it is not all. Below his signature Dr. Leidy has written a brief explanatory note:

> "The above amount is one-half of the sum paid persons through whose connivance I was enabled to procure two adipocere bodies, one for the College of Physicians, the other for the University.
> J. L. "

So it was a matter of *connivance* and no doubt the whole legend is true!

The receipt also furnishes us with the date of the presentation and, therefore, probably that of exhumation. The bodies said to have been buried in 1792 were exhumed in 1875 and with this latter date fixed, it may no longer be necessary to go back of it with our questions.

It is impossible at the present time to come into legal possession of a dead human body except by arrangement with the Pennsylvania State Anatomical Board. Otherwise to obtain one is to invite the penalty of the law.

There was a time, however, when whoever needed a dead body for dissection or other purpose, might obtain it as he could. That was the period of the "resurrection men," who robbed fresh graves and sold the bodies to doctors and to medical colleges. It came to an end when, through the influence of Prof. Forbes of the Jefferson Medical College of this city, the "Anatomical Act" was finally passed by the state legislature on March 18th, 1867.

It was eight years after that date that the exhumation of the "Petrified Lady" is said to have taken place, so that if the "connivance" mentioned in the receipt was "resurrection," it would have been a criminal transaction!

Leidy was one of the framers and backers of the Anatomical Act, and it is unthinkable that he should have lent himself to any contraversion of its purposes. Moreover, no one who knew him can imagine him guilty of any unethical or illegal act. Yet it is not impossible that his interest in science may have led to an appearance of evil where none really was, as we shall see.

Before any cemetery can be abandoned and the bodies there interred exhumed for burial elsewhere, an ordinance of the city Council must be passed, granting such permission.

Before any individual body can be exhumed for removal from one cemetery lot to another, or from one cemetery to another, permission must be given by the Health Authorities—in 1875, the Board of Health.

There are, of course, records of all such ordinances and permissions so that all of our previous investigations may have been entirely unnecessary. We needed only to refer to the Councilmanic Record to find what cemetery was abandoned in 1875, or to the minutes of the Board of Health to find the permission granted for the removal of the Ellenbogens.

Through the kindness of Director of Public Health, Dr. Hubley R. Owen, I was provided with the appropriate introductions and betook myself to the Law Library in the City Hall, where, with the aid of an assistant librarian, I went through all of the Councilmanic Records from 1870 to 1880. We found no ordinance authorizing the abandonment of any cemetery.

Discouraged, but still confident that the remaining step would uncover the mystery, I sought Mr. Johnson, who placed the Minutes of the Board of Health at my disposal, and aided me in the search. No permission for the removal of any bodies from any cemetery could be found during the same decade.

There seemed to be only one remaining possibility: the exhumations must have been private, unauthorized, surreptitious and illegal, as summed up in the word "*connivance*!"

But here we again run counter to the unimpeachable character of Prof. Leidy. Could he have permitted himself to become *particeps criminis* in the matter of the petrified bodies? Could he have become so enamored of our Petrified Lady as to have arranged an elopement? And did he, thereby, expose himself to the danger of legal pursuit and punishment? Well, here is what the law says:

"Each body shall be used only for the promotion of medical science within this state, and whosoever shall use such body or bodies for any other purpose, or shall remove the same beyond the limits of the state; and whosoever shall sell or buy such bodies or in any way traffic in the same, shall be deemed guilty of a misdemeanor, and shall, on conviction, be imprisoned for a term not exceeding five years at hard labor in the county jail!"

Imagine Prof. Joseph Leidy condemned to five years of hard labor in the county jail!!

Fortunately, however, there is a qualification by which he is exempted: the law says, "Every body shall be used only for the promotion of medical science." That is the use he made of the Ellenbogens; he did not "sell or buy" or "in any way traffic in the same." If the legend tells the truth, he simply claimed them as relatives, paid the costs incurred, and saw that they were permanently placed in museum mausoleums, in a state of importance never dreamed of during the life time of either.

Thus far our researches suggest ingenious efforts on the part of one whose conscience may have been a little troubled by the "connivance" in which he had been engaged, carefully to cover his tracks. See the point at which we have arrived:

1. No people named Ellenbogen are known to have been in Philadelphia before 1836.

2. No people of that name are known to have died of yellow fever in the year 1792.

3. There seems to have been no yellow fever in Philadelphia that year.

4. They could not have been disinterred from the neighborhood of Fourth and Race Streets because there were no cemeteries there from which they could be removed, and there is no councilmanic or other authorization for the removal of their, or any other, bodies in 1875.

You see, if a dead body be given a supposititious but possible name, be said to have died of a rare disease at a date near that of a great epidemic, be made to appear to have been buried without other care than to get it into the ground, and alleged to have been interred in a cemetery where no cemetery really was, although there were several only a few blocks away, it may never be possible to identify it.

Nothing now remains for consideration except the peculiar German name that Dr. Leidy gave the people. Their real name he may or may not have known, but certainly did not reveal. But why choose Ellenbogen?

I close with an hypothesis that may be wide of the mark, but is perhaps as good as any, and will vividly recall Leidy and his lectures to any of the few survivors of his day.

He was a great scientist, a brilliant anatomist, a good and honorable gentleman, but withal a very tedious lecturer upon a very dull subject. He probably never realized it—his interest in it would never have permitted him to do so. He had very little sense of humor and rarely introduced an anecdote or joke with which to enliven his audience.

I attended his lecture course twice, but remember only two jokes! One of them that concerns us here has to do with that bone of the skeleton known as the *humerus*. Every student knew perfectly well when it was coming, listened for it with bated breath, in perfect silence, and then burst out into enthusiastic applause and appreciation.

Leidy began his course of lectures about October first, with the description of the skeleton upon which he spent several weeks. The bones of the arm might be reached about the middle of November, a matter that it is well to keep in mind, for if there is only one joke to be told about the whole skeleton, the joker probably does not always keep it in mind, but first thinks about it as the appropriate time approaches. He then digs it up, polishes it off, and finally presents it. Here is the way the occasion was consummated:

"This, gentlemen, is the bone of the upper arm called the *humerus*. It occupies the position between the shoulder and the elbow. It is the bone often struck with painful effects and for some reason has become known as the "funny bone." There is a good reason for giving it that name. Can any one of you tell me what it is?"

The class maintaining perfect silence, with a smile the professor answers with another question—"Well, isn't it *humerus?*"

Now in November 1875 he was lecturing upon the skeleton; about the 18th the humerus would have been reached. With the elbow, the "funny" bone, and the joke fresh in mind, Leidy, of German descent and thoroughly acquainted with the language, is called upon to provide a supposititious name for his petrified bodies. Is it not possible that the elbow, in German, *Ellenbogen*, may have been the first, or at least the most appropriate that occurred to him?

Memoir of James Ely Talley*

By JAMES E. COTTRELL

JAMES ELY TALLEY was born near Kennett Square, Pennsylvania, on July 22, 1864. Because he was a reticent man, few details of his ancestry and of his childhood are available to me. One ancestor was William Talley, who came to Pennsylvania from England or Wales prior to 1686. Others were Swedes who settled at Upland, now Chester. His father, James Smith Talley, died about six months after the birth of the only child. His mother, Sarah Hannum Talley, died a few years later but not before she had instilled in her son a desire to be well educated and to follow a profession. Left without near kin, Doctor Talley lived thereafter with friends of the family.

At the age of 13 or 14 Doctor Talley went to Millersville Normal School at Millersville, in Lancaster County. At that time this school offered a curriculum about equivalent to that of a preparatory school, and it was evidently a very good one. Some members of the faculty exerted a strong influence on Doctor Talley's intellectual development and to the end of his life he treasured a little book on English Literature written by J. Willis Westlake, who was the head of the English department. One of Doctor Talley's fellow students there was Ernest Buckman of Wilkes-Barre, later a classmate in medical school. While there Doctor Talley also became friendly with a young man from Colorado, William Parfet by name, and they decided to go to college together. From a perusal of catalogs they selected the University of Michigan. To obtain additional credits for college entrance Doctor Talley attended Ann Arbor High School for two years, and entered the University of Michigan in 1885. After their Sophomore year he and William Parfet decided to transfer to Harvard but during that summer Parfet died of typhoid fever while visiting the friends with whom Doctor Talley lived at Brandywine Summit. Unwilling to go to Harvard without his companion Doctor Talley continued at the University of Michigan.

Doctor Talley entered the Medical School of the University of Pennsylvania with the class of 1892. This class was exceptional because of the large proportion of its members who subsequently played prominent rôles in Philadelphia medicine and in the activities of the College, nearly a dozen of them attaining the academic rank of Professor in various institutions. It is said that in scholastic standing William G. Spiller led the class while Doctor Talley and David Riesman were tied for second place. For a time while in medical school Doctor Talley roomed with David Riesman and Jay Frank Schamberg, and among his particular friends and associates were James McKee, Robert Pitfield, Thomas Branson, John Girvin, and Alex Davisson. A minor point of interest is that while in medical school he served as a pall-bearer at the funeral of Dr. D. Hayes Agnew.

Doctor Talley served his regular internship at Blockley after brief substitute internships at the Presbyterian Hospital and the Children's Hospital. After this Blockley service he had decided to locate in Chicago and was about to leave Philadelphia when he was offered a temporary internship on Dr. Weir Mitchell's service at the Philadelphia Orthopedic Hospital and Infirmary for Nervous Diseases. While there he was asked to accompany a patient to the mountains for the summer. This patient persuaded Doctor Talley to alter his plans and to locate in West Philadelphia; in fact, the patient lived with Doctor and Mrs. Talley for several years after their marriage. This northwest section of the city was then a rapidly growing one and Doctor Talley soon acquired a large and very active general practice. Years later it was noteworthy how many of these early patients, and their children and grandchildren after them, had remained devoted to him as friend and family adviser as well as physician. During one period of particularly heavy work in this general practice Doctor Charles A. Fife came to stay with Doctor Talley and assisted him in practice for several months; this was the chief beginning of a close and life-long personal and professional association between the two men. In 1904 Doctor Talley spent several months in postgraduate study in Berlin and in 1905 became associated with Dr. John Herr Musser, Sr. in the

* Read at the meeting of The College of Physicians of Philadelphia, February 4, 1942.

latter's office. From that time Doctor Talley restricted his practice to internal medicine with particular reference to cardiovascular diseases. The summers of 1911 and 1913 he spent in graduate work with Sir James McKenzie and Sir Thomas Lewis in London.

Of the several hospitals in which Dr. Talley worked the longest association was with the Presbyterian; first appointed a physician in the Out-Patient Department in 1897, he became Visiting Physician in 1907 and Consulting Physician in 1929. He served as a Visiting Physician to the Methodist Hospital and as Consulting Physician to the Woman's Hospital of Philadelphia and to the Eastern Penitentiary. He was made Professor of Cardiology in the Graduate School of Medicine of the University of Pennsylvania in 1921 and served until his retirement in 1938. In that capacity he organized and headed for a time the Cardiac Clinic of the Graduate Hospital. He was one of the founders of the Babies' Hospital of Philadelphia and served on its Board but not on its medical staff for some years; he also was a member of the Board of the Children's Heart Hospital.

Before the United States entered the First World War Doctor Talley held a commission in the Medical Reserve Corps of the United States Army. Believing he was bettering his chance of a prompt call to active service, in the spring of 1917 he resigned from the Army and together with Mr. Charles Scott, Jr. and Dr. Robert LeConte organized a Naval Hospital unit at the Methodist Hospital. This became Navy Base Hospital Number 5 and Doctor Talley served as the director of its medical division in Brest, France, from September 1917 to December 1918. His rank at that time was Lieutenant Commander; in 1919 he was promoted Commander and in 1926 he was honorably discharged from the Naval Reserve.

Among the societies in which Doctor Talley held membership were the Philadelphia County Medical Society, the Medical Society of the State of Pennsylvania, the American Medical Association, and the Philadelphia Pathological Society. He was a Fellow of the American College of Physicians. One of the founders of the Philadelphia Heart Association, he was its president from 1931 to 1933; and he was a member of the American Heart Association from the time of its organization. Elected a Fellow of the College of Physicians of Philadelphia in 1900, he was a familiar figure at its meetings and the meetings of its Section on General Medicine.

In the library of the College is a volume of collected reprints of articles by Doctor Talley. It comprises forty-seven titles—all papers written from the clinical view-point, concerned with the observation of, and acquaintance with, the individual as a patient and as a person. This is in keeping with the chief professional interest of the author. Unusually gifted in the art of medicine, he was primarily a clinician. He was absorbed in practice, and in a degree greater than almost any physician I have known, he inspired not only confidence, but devotion in patients.

In 1938, realizing that his health was no longer good, Doctor Talley reluctantly decided to retire. In the winter of that year, he developed an illness which produced weakness of his right side and partial motor aphasia. For one as fond as he was of association with his fellow-man, this must have been indeed a burden, but he bore it with fortitude and with cheerfulness. In the early summer of 1941 his strength failed rapidly, and he died on July 3rd.

If I were to name an outstanding characteristic of James Ely Talley, I should say that it was his love of people, his zest in relations with them. The adjectives which occur to one when one thinks of him are pleasant, heart-warming words—friendly, kindly, gentle, understanding. Knowing him rather well in his later years, I do not think I ever heard him speak harshly of anyone—if honesty compelled him to express an unfavorable opinion, it was gently said, and with full consideration of extenuating circumstances. His sense of humor was quiet, and very, very keen. His little personal mannerisms were cheery—his smile, the hand-wave of greeting which was characteristic of him, the quiet chuckle at the beginning of a funny story and the hearty laugh at its end. Altogether, he was a modest and lovable gentleman, whose most fitting monument is the one he has beyond question—the memory of him in the minds of his patients, his associates and his friends.

Memoir of Edward A. Shumway*

By H. MAXWELL LANGDON

EDWARD A. SHUMWAY was born September 3, 1870. His father was Lowell Shumway, who came from Massachusetts, and his mother Anna Bussier, of Philadelphia. He was one of four children, two brothers, a half brother and a half sister. One of his brothers, Daniel B. Shumway, was for many years head of the German Department of the University of Pennsylvania, and his half brother, Walter, was head of the Theological School of Temple University, so a strain of scholarship seems to have been in the family.

His early education was in the Philadelphia Public Schools, graduating from the Central High School with the degree of A.B., in 1887. In 1891 he received a B.S. degree from the University of Pennsylvania, and his M.D. in 1894 from the same institution. After graduating, he was an intern at the Philadelphia General Hospital. In 1896 and '97 he was house surgeon at the New York Eye and Ear Infirmary. After leaving this institution in the latter part of '97 and '98, he studied abroad, working in ophthalmology at Heidelberg, Vienna and Berlin.

He started his private practice in 1899 in Philadelphia, and became associated with Dr. William C. Posey at Howard Hospital, as chief of the ophthalmic dispensary, where he remained until 1902, when he resigned to become one of the staff of Dr. G. E. de Schweinitz, who had just been elected Professor of Ophthalmology at the University of Pennsylvania. Previous to this, in 1901 he had been associated with Dr. de Schweinitz in his private practice, being at the office a portion of each morning. This he continued until 1906, when his own practice prevented further continuance of the association.

In 1901 he married Annie Price, daughter of Dr. Mordecai Price. They had two sons, Edward A. Shumway, Jr., and Norman Price Shumway, who studied medicine, and is a Fellow of the College. Mrs. Shumway died in 1933.

In 1902 Dr. Shumway joined Dr. de Schweinitz at the University, as instructor in Ophthalmology, and assistant surgeon at the ophthalmic dispensary of the University Hospital. He held this position until 1924, when, on Dr. de Schweinitz' retirement, Dr. Shumway resigned. In the meantime he had been advanced in the Medical School to the position of Lecturer in Ophthalmology, in 1919, and Assistant Professor in 1922.

While he was performing these duties at the University Hospital he was also connected with the Philadelphia General Hospital and the Lankenau Hospital. He was assistant ophthalmologist at the Philadelphia General Hospital from 1903 to 1914, when he became one of the attending surgeons, from which position he resigned in 1926, and was made consultant ophthalmologist, a position he held until his death.

At the Lankenau Hospital he became assistant ophthalmologist under Dr. Charles Turnbull in 1906, and in 1915 one of the attending ophthalmic surgeons at the institution. He continued in this status until 1936, when he retired from the duties of active surgeon, and was made consultant ophthalmologist at the institution.

He was elected a Fellow of the College of Physicians in 1900, and a member of the American Ophthalmological Society in 1905. He was also a Member of the American Medical Association, of the Philadelphia County Medical Society, and the Medical Club of Philadelphia.

Dr. Shumway was very much interested in the work of the Section on Ophthalmology in this College, and was a very regular attendant at its meetings. From 1906 to 1909 he served as clerk to the Section, and from 1926 to 1928 was its chairman.

The following is a list of the papers which he published in conjunction with others: (*With Dr. Mary Buchanan*) Histology of the Eyes of Children with Amaurotic Family Idiocy. (*With Dr. Wm. C. Posey*) Alveolar Sarcoma of the Choroid; Carcinoma of the Eyelids. (*With Dr. de Schweinitz*) Melanoma of the Choroid; Sympathetic Disease; Vernal Conjunctivitis; Bullous Keratitis in Glaucoma; Syphilitic Papilloma of the Iris; Tuberculosis of the Choroid; Glioma of the Retina; Secondary Glaucoma; Conjunctivitis Nodosa.

* Read at the meeting of The College of Physicians of Philadelphia, May 6, 1942.

His recreation was golf, which he played at the Overbrook Golf Club. He was a member of the Phi Delta Theta College Fraternity, and the A.M.P.O. Medical Fraternity.

Dr. Shumway was not what one would call a gregarious man. His retiring disposition did not lead him to seek human companionship just for its own sake. With a group, in ordinary social intercourse, his voice would be seldom heard unless there was something definite which he wished to contribute to the conversation. If he was amused by any happening the response would be more likely to be a chuckle than a hearty laugh, not because he did not enjoy it, but because any undue emotion was apart from him.

Dr. Shumway was not one who developed new ideas or techniques in the practice of his profession, but was one who thoroughly and most competently did the things that were to be done for the benefit of his patients, and carried them out with thoroughness. His patients were very devoted to him, and his practice was founded on the solid friendship and admiration of those who went to him.

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Transactions of the Sections

SECTION ON GENERAL MEDICINE

Regular Meeting, March 23, 1942

CIRCULATORY DISTURBANCES IN THE EXTREMITIES. David W. Kramer*, M.D.

A DISORDER OF BLEEDING ACCOMPANIED BY DELAYED HEALING OF WOUNDS. L. M. Tocantins, M.D.

CLINICAL EVALUATION OF SERUM LIPASE DETERMINATIONS. H. L. Bockus, M.D., and T. A. Johnson, M.D.

THE PROLONGED USE OF MERCUPURIN IN CONGESTIVE CARDIAC FAILURE. REPORT OF A CASE RECEIVING 437 INJECTIONS OVER A PERIOD OF FIVE YEARS. AUTOPSY. William G. Leaman, Jr., M.D.

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TUBERCULOUS PERICARDITIS. REPORT BASED ON A STUDY OF 100 CASES. Samuel Bellet*, M.D., and Thomas M. McMillan, M.D.

INTERMITTENT CLAUDICATION RELIEVED BY THYROIDECTOMY. Joseph C. Doane, M.D., and Albert Adlin*, M.D.

A STUDY OF SOME UNUSUAL MENSTRUAL MOLIMINA AND THEIR ENDOCRINE TREATMENT. Abraham E. Rakoff*, M.D.

Meeting Scheduled for May 25, 1942

(Cancelled Owing to Conditions Brought About by the War.)

SECTION ON MEDICAL HISTORY

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SCIENTIFIC ACCOMPLISHMENTS OF THE UNITED STATES ARMY MEDICAL CORPS.[1] Edgar Erskine Hume*, Colonel, Medical Corps, U. S. Army.

Regular Meeting, April 13, 1942

RUDOLF VIRCHOW AND THE FRANCO-PRUSSIAN WAR. H. G. Schlumberger*, M.D.

THE SHROPSHIRE LASS AND HER GOITER. Robert L. Pitfield, M.D.

* *By invitation.*

[1] Colonel Hume's monograph, parts of which were read at this meeting, appears, *Part I* in the April, *Part II* in the June, 1942, numbers of the *Transactions & Studies.*

SECTION ON OPHTHALMOLOGY[2]

Regular Meeting, March 19, 1942

OCULAR PHENOMENA ELICITED BY WITHDRAWAL OF AQUEOUS IN MAN. Peter C. Kronfeld*, M.D.

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BILATERAL BLINDNESS DUE TO LESIONS IN BOTH OCCIPITAL LOBES. Joseph C. Yaskin, M.D., and Anthony Tornay*, M.D.

HYDROPHTHALMOS. Isaac S. Tassman, M.D.

WHITE RINGS IN THE CORNEA (COATS): REPORT OF FIVE CASES. Joseph Waldman*, M.D.

FÖRSTER'S LUETIC CHOROIDITIS. George P. Meyer, M.D., and Joseph V. Klauder, M.D.

SECTION ON OTOLARYNGOLOGY[3]

Meeting, March 18, 1942[4]

THE SPECIALIST IN THE ARMY. Alfred W. Doust, Lieutenant, M.C., U.S.A.

OTOLARYNGOLOGICAL ASPECTS OF AVIATION. Leon D. Carson, Lt. Commander, M.C., U.S.N.

WAR CASUALTIES IN THE NAVY. Reynolds Hayden, Captain, M.C., U.S.N.

Regular Meeting, April 15, 1942

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PATHOLOGIST'S POINT OF VIEW. John Eiman, M.D.

HEMATOLOGIST'S POINT OF VIEW. Max M. Strumia, M.D.

OTOLARYNGOLOGIST'S POINT OF VIEW. M. Valentine Miller, M.D.

SECTION ON PUBLIC HEALTH, PREVENTIVE AND INDUSTRIAL MEDICINE

Meeting, April 6, 1942

SYMPOSIUM ON MEAT INSPECTION

MEAT INSPECTION IN RELATION TO PUBLIC HEALTH. R. A. Kelser*, V.M.D., Brig. General, U.S.A.

MEAT INSPECTION IN PHILADELPHIA. Elkan H. Yunker*, V.M.D.

FILTH AND ADULTERATION IN MEAT FOOD PRODUCTS. Joseph W. E. Harrison*, P.D.

[2] The transactions of this Section are customarily abstracted in the *American Journal of Ophthalmology* and the *Archives of Ophthalmology.*

[3] The transactions of this Section are customarily abstracted in the *Archives of Otolaryngology.*

[4] Joint meeting with the Section of Otolaryngology of the New York Academy of Medicine, at the Academy.

TRANSACTIONS & STUDIES

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The Plasma Proteins: Their Properties And Functions[1,2]

By EDWIN J. COHN

Department of Physical Chemistry, Harvard Medical School, Boston, Mass.

PLASMA is one of the most important of the body fluids. Its physiological functions are of profound significance to those concerned with water and electrolytes, with hormonal and with protein systems; its therapeutic uses to those concerned with blood coagulation, with immunity and with the treatment of shock.

The plasma contains fats and carbohydrates and we know that these occur in various metabolic states and in a very labile equilibrium. The plasma contains enzymes that play their complex roles in these metabolic processes, and intermediary products of metabolism, certain of which appear to have hormonal functions. The plasma contains waste products of the tissues, as well as components for the repair of the tissues, both in amounts which vary widely about the mean which constitutes the physiological state. The plasma may contain virus proteins, other antigens of foreign origin and the antibodies to them, derived from native globulins, as well as the large number of complex proteins native to the blood.

The most mobile constituent of the blood stream is water. Water represents over ninety per cent of normal plasma. Changes in water balance in the body are reflected by changes in the water content of the plasma. The red blood corpuscles, as well as the other body tissues, are in equilibrium with the plasma, and changes in the volume of these red cells—or of the concentration of the hemoglobin that they contain—are commonly employed as an indication of changes in the body fluids and tissues. Thus, hemoconcentration, a frequent concomitant of shock, clearly recognized by Starling, generally indicates passage of water from plasma to the tissues. One form of therapy has consisted in the injection of plasma proteins with the intent of withdrawing water from the tissues, thus effecting a hemodilution in order that the blood may again approach its normal physiological properties and its normal circulation be restored.

Hemodilution follows the injection of concen-

[1] Alvarenga Prize Lecture III (Award XXXVII), The College of Physicians of Philadelphia. Read at the College, October 14, 1942, before a joint meeting of the College and The Philadelphia County Medical Society. Lectures delivered before joint meetings of these organizations may appear either in the *Transactions & Studies* or in the Society's publication, *Philadelphia Medicine*, or in both. This lecture will appear only in the *Transactions & Studies*.

[2] The pressure of the times has prevented the preparation of a comprehensive bibliography. References are given to the source of the measurements reported in tables and figures. For a partial list of those who have made valuable contributions to this field see *Chem. Rev.*, **28**, 395 (1941), and a bibliography prepared for the paper by Cohn, E. J., Oncley, J. L., Strong, L. E., Armstrong, S. H., Jr., Ferry, R. M. and Hughes, W. L. Jr. in "Blood Substitutes and Blood Transfusion," C. C. Thomas, Springfield, Illinois (1942), pages 180–183.

trated salt or glucose solutions, but the osmotic effect of these small molecules is of short duration, since they readily leave the blood stream, through the capillary walls, which are permeable to molecules of this size. The molecular weight of glucose is 180.0, of the chloride ion 35.5, of the sodium ion 23.0, and of water 18.0. The volumes and effective diameters of such molecules are small in comparison with those of the plasma proteins. Thus the molecular weight of serum albumin is close to 70,000; that of most serum globulins is in the neighborhood of 150,000; and certain of the serum globulins of significance in immunity have molecular weights of 900,000 or more. Molecules of the size of the plasma proteins do not normally pass through the walls of blood vessels in large amount, or through the kidney, although they may, of course, do so under conditions of altered permeability.

The chemist does well in planning his work to defer to the philosopher. The philosophy of the chemist—in the twentieth century—has often been mechanistic and so has that of many physiologists. But the thinking of some physiologists has not been uninfluenced by teleology; the theory which assigns a definite end or ends in explanation of the structure and behavior of things.

If the chemist is to develop a therapeutic agent whose function is to draw water into the blood, and restore its effective circulation, what physical properties should he as a teleologist specify for the blood substitute?

THE CONCEPT OF ISOTONIC SOLUTION

Nineteenth-century botanists considered the forces necessary to draw water into tissues. Following the pioneering studies of Pfeffer and of de Vries on the passage of water through membranes, van't Hoff developed the concept of osmotic pressure. The theory of osmotic pressure that was first suggested has been superseded. The phenomenon, first studied extensively in the last century in terms of the rupture of plant cells and of red blood cells, remains, however, the most important that we know in connection with water balance.

Plant cells, and animal cells, are surrounded by membranes. These membranes are impermeable to the substances of larger molecular weight which make up the greater part of the constituents of such cells, but are permeable to water and to many smaller molecules. It is the substances that cannot pass through the cell walls into the body fluids which cause the water in our body fluids to penetrate the cell walls and dilute them. The force or pressure with which the non-diffusible contents of cells attract water was called osmotic pressure by the early workers in the field. Let us reconsider the classical studies of Pfeffer upon osmotic pressure.

Pfeffer made an artificial cell through which water could pass, but through which molecules of sugar could not pass. He made his cell by depositing copper ferrocyanide in the pores of a clay vessel. The membrane was the precipitate of copper ferrocyanide, and the clay walls functioned merely to give strength in order that the membrane might withstand the pressures that were developed. Pfeffer connected such an artificial osmotic cell containing a sugar solution to a manometer and immersed the cell in a beaker of water. The sugar solution could not pass the walls of the cell and was accordingly prevented from diffusing equally through the contents of the beaker, as it would have done if no membrane had been present. As a result the water passed through the walls of the membrane to dilute the sugar solution, and the pressure developed in this way could be read upon the manometer. Pfeffer discovered that the pressure developed by a sugar solution was almost exactly proportional to the concentration of sugar within his membrane. The results of some of his experiments published in 1877 are reproduced in Table I.

TABLE I

*Osmotic Pressure of Sugar Solutions (Pfeffer)**

Concentration	Pressure	P/C
1%	535 mm.	535
2%	1016 mm.	508
4%	2082 mm.	521
6%	3075 mm.	513

* Pfeffer, W., "Osmotische Untersuchungen. Studien zur Zellmechanik," W. Engelmann, Leipzig (1877), p. 81.

And now we must consider those developments arising from Pfeffer's experiments which concern us still more closely: the osmotic pressure of cells. Stimulated by Pfeffer's experiments, de Vries began to study the plasmolysis of plant cells and Hedin and Hamburger the laking of red blood cells. They immersed red blood cells in sugar solutions and in solutions containing different concentrations

of salt, and discovered that if solutions were employed whose strength was greater than a certain value, the red blood cells would lose water, and, as a consequence, would shrink. On the other hand, if the red blood cells were immersed in distilled water or in dilute salt solutions they would take up water from the environment, burst cell walls, and the hemoglobin would flow out. The cells were laked. Salt solutions sufficiently dilute to allow cells to imbibe water from them were termed hypotonic, and salt solutions so strong as to extract water from cells hypertonic. Salt solutions or sugar solutions which caused no change in the volume of the red blood cell were termed isotonic. Such salt solutions were considered to be in equilibrium with the contents of the cell.

A series of experiments with varying salt concentrations carried out by Hedin at this time is given in Table II. If he used a salt solution that was too dilute, the red blood cells would take up water, swell and increase in size, whereas in concentrated salt solution they would shrink.

That other tissues were subject to the same laws of osmotic pressure relating concentration of salt or of sugar to water balance was soon recognized. Loeb, in 1913, quotes some experiments of Webster upon the gastrocnemius of the frog immersed in various hypo- and hypertonic solutions. For the muscle, as for the red blood cell, there is an equilibrium condition in which there is no exchange of water between the tissue and the solution which surrounds it.

In these early experiments on the change in volume of erythrocyte and muscle cells with change in salt or sugar content of their environment, the walls of the cell membranes remained impermeable to the large structural elements within the cells, to the hemoglobin of the red blood cell, to the muscle proteins of the gastrocnemius. The sugar solutions in which the cells were immersed freely passed through the walls of these cells, but were retained at the concentrations at which they were desired by the laboratory vessels in which the experiments were carried out. They could not pass through the wall of the beaker, they could not vanish into tissue spaces, readily pass the kidney or leave the body through the oozing surface of a burn.

If a salt or sugar is dissolved in water within a membrane immersed in a beaker of water and the membrane is permeable to the dissolved substance there will be two opposing processes simultaneously proceeding. 1) Water will flow through the membrane to dilute the dissolved substance. 2) The dissolved substance will diffuse through the membrane into the outer liquid. The rate at which these two processes will take place will depend upon the diffusion rate, respectively, of the solvent and of the dissolved substance. The pressure, high at first, will diminish as the solute passes into the outer liquid, and at the time that concentration of the solute is equal on both sides of the membrane the solutions will be isosmotic. No force will remain drawing water within the membrane.

TABLE II

*The Effect of Hyper- and Hypotonic Solutions upon the Volume of the Red Blood Cells (Hedin)**

Tonicity of Solution	Concentration of NaCl	Per cent of NaCl	Volume of Red Blood Cell
Hypotonic.....	0.08	0.45	50.2
Hypotonic.....	0.12	0.67	44.2
Isotonic.....	0.16	0.90	40.4
Hypertonic.....	0.20	1.12	38.0
Hypertonic.....	0.24	1.35	36.8

* Hedin, S. G., *Skand. Arch.*, **5**, 238 (1895), quoted by Loeb, J., *Science*, **37**, 427 (1913), from more extensive data.

TABLE III

*The Effect of Hyper- and Hypotonic Solutions upon the Gastrocnemius of the Frog (Webster)**

Tonicity of Solution	Concentration of NaCl	Per cent of NaCl	% Change in Wt. of Muscle	Concentration of Sugar	% Change in Wt. of Muscle
Hypotonic....	0.033	0.016	+25	0.05	+26
Hypotonic....	0.065	0.032	+13	0.12	+11
Isotonic.....	0.125	0.065	0	0.23	−1
Hypertonic....	0.25	0.13	−7	0.45	−12
Hypertonic....	0.5	0.27	−13	0.87	−27
Hypertonic....	M	0.54	−17	1.67	−40

* Webster, R. W., Univ. of Chicago, Decennial Publications, **10**, 105 (1902), quoted by Loeb, J., *Science*, **37**, 427 (1913).

The blood vessels are permeable to water, glucose and sodium chloride. Although there will thus

be an immediate effect of hemodilution following the injection of a concentrated salt or glucose solution, this effect will diminish with time. The constant which defines the rate of diffusion in water at 20° is 139×10^{-7} for sodium chloride and 64×10^{-7} for glucose.

The smaller the diffusion constant of the injected substance, the more prolonged will be the hemodilution, that is, for the case of diffusible substances, of substances to which restraining walls are permeable. The diffusion constants of the plasma proteins are of a different order of magnitude from salt and sugar. The diffusion constant of serum albumin is approximately 6×10^{-7} and of serum globulin 4×10^{-7} at 20°. Under conditions of free diffusion their rate of movement is thus ten or fifteen times as slow as glucose or twenty to thirty times as slow as sodium chloride.

OSMOTIC PRESSURE OF PLASMA AND OF THE PLASMA PROTEINS

The plasma proteins do not pass freely through the blood vessels and kidney under normal conditions. Their function is to be compared therefore less with that of freely permeable smaller molecules than of the substances of tissues which do not diffuse from the intact cell; with the hemoglobin of the red cell (see Table II) and with the proteins of the muscle (see Table III). Each of these substances of large molecular weight also exerts osmotic pressure, however, and since this osmotic pressure will not diminish with time, due to diffusion through the cell walls to which they are impermeable, the force which they exert is sometimes termed "colloid osmotic pressure," or, more recently, "oncotic pressure." But this is the original definition of osmotic pressure, and one to which we may well revert. An early attempt to relate the osmotic pressure of plasma to the average molecular weight of the plasma proteins was made by Starling before the turn of the century.

Osmotic pressure is as a first approximation dependent upon the number of molecules or ions in a given volume of solution. The osmotic pressure of equal weights of sodium and chloride ions, of glucose and of serum albumin through membranes impermeable to all of them would be, as a first approximation, inversely proportional to the molecular weights of the substances. This is sometimes called the "total osmotic pressure", and may be calculated from freezing point or vapor pressure measurements. In cases in which membranes are freely permeable to the smaller molecules, the osmotic pressure of salt and sugar at equilibrium may be taken as close to zero and their effects on therapy are therefore determined largely by their diffusion constants.

The smaller the diffusion constant the larger the molecular weight and therefore the smaller the osmotic pressure. For the case of molecules to which cell walls are not permeable therefore the smaller the molecular weight and the larger the diffusion constant, the greater the osmotic effect. There is, however, a lower limit to the size of a protein that can exert steady osmotic pressure; namely, the size of molecules that will not too readily be lost from the blood stream. We know that Bence-Jones protein passes into the urine, and its molecular weight is under 40,000. Egg albumin, recently studied by Bott and Richards, passes through the glomerular filter, though not freely, and its molecular weight is now estimated to be just over 40,000. The molecular weight of hemoglobin is generally given as 68,000, or close to that of serum albumin. It breaks down into molecules of half this size under a variety of conditions which appear not to affect the serum albumin molecule, however; though it has not been proven conclusively that this difference is of physiological significance.

The colloid osmotic pressure of the plasma is exerted almost completely by the plasma proteins, and their molecular weights are now relatively well known, both as a result of osmotic pressure and of diffusion and ultracentrifugal measurements. Approximately sixty per cent of the protein of normal human plasma is albumin of molecular weight near 70,000. Of the globulins, the molecular weights of all but a few per cent fall between 140,000 and 200,000.

The largest component thus far studied is the globulin, which is elevated in sera immune to pneumonia, which aggregates so as to yield molecules of even larger molecular weight, especially in the case of horse antipneumococcus sera (Table IV). There is also an α-globulin fraction which appears to dissociate into molecules approximately the size of the albumins (Table V).[3] The importance of

[3] In the absence of more precise knowledge of the normal concentration—and concentration in pathological conditions—of the dissociated and aggregated serum globulins we may tentatively assume, for convenience, that the changes in osmotic pressure due to these changes in molecular weight balance each other.

studying the variation in concentration of these proteins of variable molecular weight, both in the laboratory and in the clinic, can scarcely be overemphasized.

On the basis of their size alone the osmotic pressure due to the albumins should be more than twice as great[3] as that due to the other plasma proteins. The sixty per cent of albumin in human

TABLE IV

Dimensions of Plasma Proteins, Sodium Chloride, Glucose and Red Blood Cells

	Diffusion Constant	Sedimentation Constant	Molecular Weight	Approximate Dimensions	
				Length of Ellipsoid	Equatorial Diameter of Ellipsoid
	$D_{20,w} \times 10^7$	$S_{20,w}$	M	*Ångstrom Units*	
Water			18.0	3.9[a]	
Sodium Chloride	139[b]		58.5	1.9, 3.6[p]	
Glucose	64[b]		180.1	7.2[a]	
Serum Albumin:					
Horse	5.8[c], 6.1[d]	4.1[c], 4.5[d]	68,000[c], 70,000[d]		
Bovine	6.4[e]	4.5[e]	68,000[e]	150[f]	38[f]
Human	6.1[e]	4.6[e]	72,000[e]		
Serum Globulin:					
Total Globulin (Horse)	4.0[d]	7.1[d]	167,000[d]	280[g]	37[g]
γ Pseudoglobulin (Horse)	4.1[h]	6.5[h]	142,000[h]	330[i]	42[i]
γ Serum Globulin (Human)	3.8[d]	7.1[d]	176,000[d]	320[j]	36[j]
Antipneumococcus (Human)	3.6[d]	7.4[d]	195,000[d]	338[g]	37[g]
Antipneumococcus (Horse)	1.8[d]	19.3[d]	910,000[d]	950[g]	47[g]
Fibrinogen		7.6[k]		(1000)[m]	
Red Blood Cells				20,000[n], 26,000[o]	76,000[n], 86,000[o]

[a] Calculated from molal volume, assuming spherical shape.

[b] From International Critical Tables, McGraw Hill, New York (1929).

[c] Unpublished measurements of Mehl, J. W. and Oncley, J. L. These values give the same molecular weight as observed in reference *d*, but a slightly greater frictional ratio f/f_o.

[d] From Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge," Table 48, page 406, Oxford Press, (1940).

[e] Unpublished measurements of Oncley, J. L.

[f] Computed for an axial ratio, a/b, of 4 and a hydration of 0.2 gram of water per gram of protein. (Oncley, J. L., *Ann. N. Y. Acad. Sci.*, **41**, 121 (1941).)

[g] From Neurath, H., *J. Am. Chem. Soc.*, **61**, 1841 (1939). The method used assumes that the ellipsoid must be elongated and neglects any hydration of the molecules, thus representing a maximum amount of asymmetry.

[h] From Cohn, E. J., McMeekin, T. L., Oncley, J. L., Newell, J. M., and Hughes, W. L., *J. Am. Chem. Soc.*, **62**, 3386 (1940).

[i] Computed for an axial ratio, a/b, of 8 and a hydration of 0.5 gram of water per gram of protein. (Oncley, J. L., *Chem. Rev.*, **30**, 433 (1942).)

[j] The dimensions are calculated by the method described in note *g*.

[k] Tentative value for bovine fibrinogen reported by Cohn, E. J., *Chem. Rev.*, **28**, 395 (1941).

[m] Estimated from sedimentation constant and viscosity measurements. This value only indicates that the molecules are quite long.

[n] Results reported on dried cells.

[o] Results reported on wet cells.

[p] These are the diameters of the sodium and chloride ion, respectively, as given by Pauling, L., "The Nature of the Chemical Bond," Cornell University Press, Ithaca, New York, 1939; 2nd ed., 1940.

plasma should thus exert at least three-quarters of its colloid osmotic pressure. As we shall see, it exerts slightly more as a result of other properties of the molecules.

The osmotic pressure of purified albumins, both of human and animal plasmas, has recently been very accurately measured by Scatchard, Batchelder and Brown. Their measurements in dilute protein solution are graphically represented in Figure I. The ratio of the osmotic pressure to the concentration of the protein (P/C) is plotted as the ordinate against the concentration of protein as abscissa, concentration being in grams per kilogram of water.

Over this concentration range, all the measurements fall on straight lines which extrapolate to the same origin. The value of the origin permits a calculation of the molecular weight of serum albumin as 68,800, in very good agreement with the value deduced from sedimentation and diffusion measurements.

These measurements permit three other deductions to be made. 1) From the point of view of osmotic pressure there is little difference in the properties of human and bovine serum albumin. 2) The osmotic pressures of these albumin solutions reflect forces not observed in Pfeffer's study of sugar solutions which cover the same concentration range (Table I). The ratio (P/C) is not constant but increases with increasing protein concentration. 3) The slope of the straight lines in Figure I is greater near the pH of the blood than near the isoelectric point of the protein. That is to say, the effect of each gram of albumin on osmotic pressure is greater the greater the albumin concentration and the higher the valence of the albumin, that is, the more of it is present as a sodium salt.

TABLE V

Dimensions of Bence-Jones Proteins, Normal and Dissociated Hemoglobin, Egg Albumin, and Denatured Serum Albumin

	Diffusion Constant	Sedimentation Constant	Molecular Weight	Approximate Dimensions	
				Length of Ellipsoid	Equatorial Diameter of Ellipsoid
	$D_{20,w} \times 10^7$	$S_{20,w}$	M	*Ångstrom Units*	
Denatured Serum Albumin in Urea (Horse)	4.2[a]		67,000[a]	359[b]	20[b]
Dissociated Serum Globulin (Human)		3.6[c]	(80,000)[c]	(310)[c]	(24)[c]
Normal Carboxyhemoglobin (Horse)	6.3[d]	4.4[d]	68,000[d]	155[b]	32[b]
Dissociated Hemoglobin (Horse)	7.8[e]	3.2[e]	39,000[e]	118[b]	28[b]
Egg Albumin	7.8[d]	3.6[d]	44,000[d]	124[f]	31[f]
Bence-Jones Protein, α		3.7[d]	35,000[d]	43[b]	43[b]
Bence-Jones Protein, β	7.3[d]	2.8[d]	38,000[d]	144[b]	25[b]

[a] From Neurath, H. and Saum, A. M., *J. Biol. Chem.*, **128**, 347 (1939). A similar diffusion constant and larger molecular weight (78,000) were reported by Neurath, H., Cooper, G. R., and Erickson, J. O., *J. Biol. Chem.*, **142**, 249 (1942). These later results would lead to somewhat greater symmetry, with maximum values of equatorial diameter of ellipsoid equal to about 27 Å, and length 360 Å.

[b] From Neurath, H., *J. Am. Chem. Soc.*, **61**, 1841 (1939). The method used assumes that the ellipsoid must be elongated and neglects any hydration of the molecules, thus representing a maximum amount of asymmetry.

[c] Value of sedimentation constant is that observed for one component of α-globulin from horse serum (Cohn, E. J., McMeekin, T. L., Oncley, J. L., Newell, J. M., and Hughes, W. L., Jr., *J. Am. Chem. Soc.*, **62**, 3386 (1940)). Molecular weight is assumed to be approximately half of the figure usually given for normal serum globulin. The dimensions are calculated by the method described in reference *b*.

[d] From Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge," Table 48, p. 406, Oxford University Press, Oxford (1940).

[e] Values obtained by Steinhardt, J. (*J. Biol. Chem.*, **123**, 543 (1938)) from experiments in concentrated urea solutions.

[f] Computed for an axial ratio, a/b, of 4 and a hydration of 0.2 gram of water per gram of protein. (Oncley, J. L., *Ann. N. Y. Acad. Sci.*, **41**, 121 (1941).)

These effects become even more pronounced in more concentrated albumin solutions in which the linear relation between (P/C) and C does not obtain. (Figure II.) Over this range also osmotic pressure measurements demonstrate the very com-

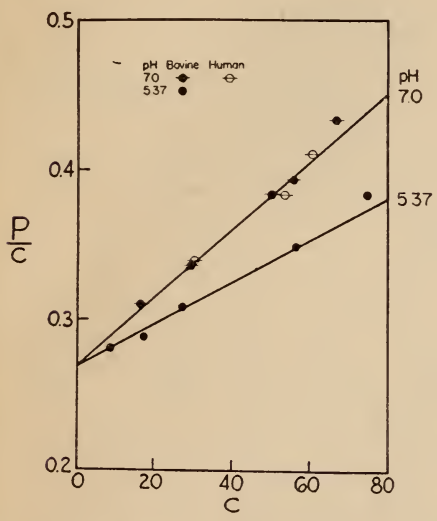

FIG. I. Serum albumin in 0.15 M NaCl. Pressure-concentration ratio vs. concentration.

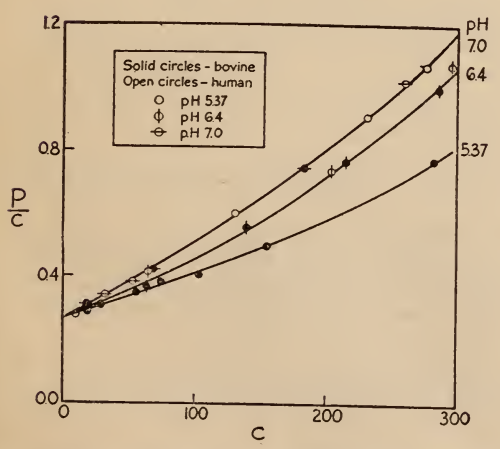

FIG. II. Serum albumin in 0.15 M NaCl. Pressure-concentration ratio vs. concentration.

parable osmotic properties of bovine and human serum albumins.

The greater osmotic pressure of the sodium salt than of isoelectric albumin is illustrated in Figure III, in which the ordinate is the value of (P/C) in 6% solution and the abscissa pH.

These measurements were carried out in the presence of an isotonic sodium chloride solution. The values in Table VI are close to those which may be expected to obtain under physiological conditions (although the temperature of these experiments for technical reasons was maintained at 25° C.). The total as well as the colloid osmotic pressures have been calculated and are recorded in the table, since they indicate immediate tendencies, though not the colloid osmotic pressures upon which protracted osmotic effects depend. Whether the immediate effects of high salt concentration are beneficial or deleterious in shock is a clinical problem, which is probably more related to effects of the salt other than those on water balance.

The osmotic pressures of serum and plasma, as well as of 4 times concentrated plasma, are also

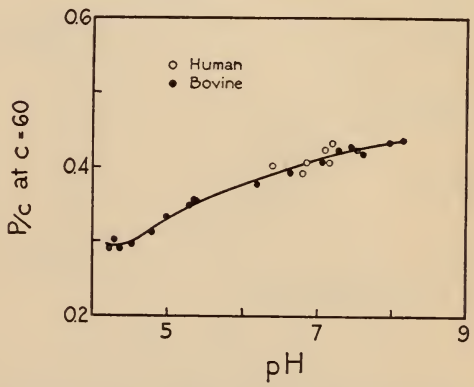

FIG. III. Serum albumin in 0.15 M NaCl. Pressure-concentration ratio vs. pH.

reported in Table VI. The "total osmotic pressure" of a 4 times concentrated plasma is, of course, far greater than that of the other protein solutions, since in concentrating a plasma the salt is also increased to 4 times the physiological concentration. This is not true of the 25% albumin solutions which can be prepared containing any kind and concentration of salt or of other components which may be found advantageous, either for its stability or for its therapeutic effects.

The simplest generalization that can be made from these osmotic pressure measurements, which confirms certain earlier studies, notably those of Peters, is that the albumins, although present in plasma to only approximately 60%, are responsible for approximately 80% of the osmotic pressure of human plasma.

LOSS OF PROTEINS FROM THE PLASMA

Is albumin more likely than globulin to leave the blood stream? In the case of a small change in permeability in the surrounding membranes, it surely is. Recent studies, both dielectric and electrophoretic, of the distribution of the plasma proteins not alone in urine but in body fluids, carried out in Sweden, at the Rockefeller Institute, and in our laboratory, suggest, however, that the old notion of albuminuria must be revised. Generally a number of different plasma proteins, characteristic of the pathological condition, pass from the blood stream. The electrophoretic distribution of protein components appearing in the urine under certain pathological conditions, is more nearly that of normal plasma than is the distribution in the pathological plasma itself. This implies, to be sure, a greater loss of albumin from the plasma than of globulin, especially in the case of an albumin-poor plasma. In the case of serous effusions also, "albumin is present in the same or higher proportion, in the effusion, as compared

TABLE VI

Osmotic Pressure of Serum, Plasma, and Plasma Proteins

	Total Osmotic Pressure in Solutions of		Colloid Osmotic Pressure-Conc'n. Ratio in 0.15 M NaCl, pH 7.4, (P/C) for C = 0	Colloid Osmotic Pressure of Protein Solutions in 0.15 M NaCl, pH 7.4	
	6%	25%		6%	25%
	mm. Hg	*mm. Hg*	*mm. Hg/gm. 100 cc.*	*mm. Hg*	*mm. Hg*
NaCl	37,000[a]	206,000[a]			
Glucose	6,400[b]	33,100[b]			
Serum Albumin:					
Horse			2.6[c]		
Bovine	5,700[d]	8,200[d]	2.7[d]	27[d]	350[d]
Human	5,700[d]	9,100[d]	2.7[d]	27[d]	355[d]
Total Globulin:					
Bovine			1.1[c]	6.5[c]	
Fibrinogen			0.9[e]		
Serum			2.2[d]	21[d]	
Plasma	6,200[g]		2.1[d]	20[d]	
Plasma, 4× Concentrated		33,000[g, h]			280[h, g]
Blood				20[f]	

[a] On basis of total osmotic pressure. Calculated from molecular weights.

[b] International Critical Tables, IV, 430.

[c] Adair, G. S., and Robinson, M. E., *Biochem. J.*, 24, 1864 (1930). Phosphate buffer solutions were used as the solvent.

[d] Scatchard, G., Batchelder, A. C., and Brown, A. Buffalo meeting, Am. Chem. Soc., September, 1942. Also unpublished results. The total osmotic pressures of bovine and human albumin solutions were calculated from the freezing points of solutions prepared at the Department of Physical Chemistry, Harvard Medical School. The colloid osmotic pressure of 25% bovine albumin solution is estimated from measurements at pH 7.0, the electrolyte, 0.15 M NaCl.

[e] Scatchard, G., Batchelder, A. C., and Brown, A. Unpublished results. A preliminary estimate from measurements on 2.2% solutions in 20% glycerol, in the presence of sodium phosphate buffers, pH 7.0, $\Gamma/2 = 0.6$.

[f] For 6% plasma proteins. The osmotic pressure of blood and of plasma are taken as equal at equal plasma protein concentrations.

[g] Calculated from unpublished measurements by Scatchard, G., Batchelder, A. C., and Brown, A., of the freezing points of solutions of commercial dried plasma.

[h] The salt is also concentrated fourfold.

with plasma, and β-globulin and fibrinogen in lower proportion," (Luetscher). This is illustrated graphically in the accompanying Figure IV.

It would be important to know whether the deductions drawn from the study of serous effusions applied equally to the oozing from burns. I have not seen the results of any comprehensive study of this kind, but one could readily be made, and I trust will be. The recent analytical evidence suggests, however, that although there is a somewhat greater loss of albumin than of globulin or fibrinogen from the blood stream, the differential loss is far smaller than might have been expected.

The physical chemist, knowing little of the conditions for the passage of molecules through the walls of blood vessels or the kidney under pathological conditions, though he assumes altered permeability, considers also in this connection the dimensions of the molecules.

There are a number of methods, all related to the frictional resistance to the movement of large molecules in liquids, on the basis of which estimates of the shape and size of proteins have been made. These estimates differ somewhat, depending upon the method of investigation and of calculation, and depending upon whether allowance is made for water carried with the protein molecule. Nonetheless, the results from more than one laboratory are satisfactorily concordant. They indicate that none of the blood proteins can be considered spherical, although albumins are more nearly so than globulins. Approximate dimensions estimated as though plasma proteins were ellipsoids of revolution suggest that they differ in length, but that the diameter of all human serum proteins thus far investigated is in the neighborhood of 40 Å.

The difference between 40 Å and the very much smaller dimensions of water, salt and sugar is striking. So also is the similarity between the diameters of albumins and globulins. Membranes that can separate these proteins from smaller molecules can readily be visualized. Differences in the rate of passage of these normal proteins through a membrane of pore size somewhat greater than that of their diameters would appear to depend upon statistical considerations related to the lengths of the molecules (see Table IV). Estimates of the dimensions of proteins, some of which are known to appear in the urine, are listed in Table V. In at least certain cases diameters of 30 Å or less have been calculated. The results are suggestive, but more evidence is needed before final conclusions can be drawn. The early study on a Bence-Jones protein appears as an exception. On the other hand, the difference in shape of the serum albumin preparations (horse) studied in Upsala and by Oncley and Mehl in our laboratory, and of the denatured serum albumin studied by Neurath at Duke University, demands further investigation. All have the same molecular weight.

If we now turn to hemorrhagic conditions in which not only proteins but also red cells escape from the blood vessels we must consider a totally different order of dimensions. Instead of molecular dimensions of the order of hundreds of Ångstroms the dimensions of a normal red cell may be taken as approximately equal to a disk with a mean diameter of from 76,000 to 86,000 Å (7.6 to 8.6 μ)

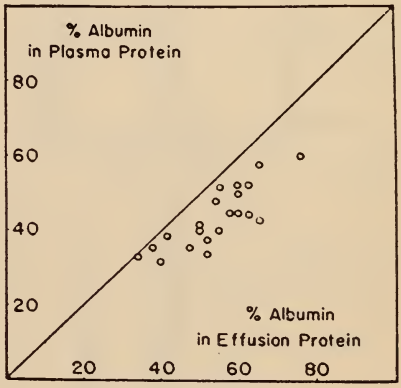

FIG. IV. The relation between the proportions of albumin in plasma and in serous effusions. From Luetscher, J. A., Jr., *J. Clin. Invest.*, **20**, 104 (1941).

and with a mean thickness of from 20,000 to 26,000 Å. In the case of an opening large enough for the passage of a red cell, the difference in the sizes of albumin and globulin molecules would not be expected to have a greater influence than is indicated by the diffusion constants of the molecules; rather, one would expect it to be smaller since one is here concerned less with the diffusion of molecules than with the flow of the plasma, or rather, of the blood.

Indeed, the most asymmetric molecule of the blood stream is fibrinogen. The molecular weight of fibrinogen has not yet been accurately determined. The molecule is rod-shaped, however, having a length estimated by one method to be as great as a thousand Ångstroms. Once more the teleologist cannot resist considering the relation between the properties of this molecule and its function in the clotting of blood.

INFLUENCE OF THE SHAPE OF PROTEINS ON THE VISCOSITY OF SOLUTIONS

The viscosity of solutions is influenced far more by the shape of molecules than by their size. Indeed, the simple theory, which cannot be completely applicable to protein solutions such as plasma—and far less so to blood—demands that the viscosity of solutions of spherical, incompressible, uncharged substances be the same, regardless of their size, provided they occupy the same volume fraction. Solutions of fibrinogen and the globulins are more viscous than those of albumins, not because the molecules are larger but because they are more asymmetrical. The ratio of the axes in the case of the serum proteins that have thus far been most completely studied by various methods, namely the serum albumin and γ pseudoglobulin of the horse, is given in the first column of Table VII. The evidence thus far available suggests that the shape as well as the size of the comparable proteins of human and animal plasmas is very similar. The relative viscosities of solutions of the albumins of different species have been studied and are compared with the viscosities on the one hand of salt and glucose solutions, on the other with that of human serum, plasma and blood.

Blood, plasma and serum are all more viscous than albumin, but less viscous than globulin or fibrinogen solutions of the same concentration. Thus the viscosity of blood with hematocrit 40 is of the same order of viscosity as 6% plasma, that of serum and serum albumin is far smaller than even a 2.2% solution of fibrinogen. These more asymmetric proteins, despite their smaller concentration in plasma, thus exert a greater effect on viscous than on osmotic properties. This becomes especially noteworthy in the comparison of hypertonic albumin and plasma. Fourfold concentrated plasma is approximately ten times as viscous as normal plasma and almost three times as viscous as a 25 per cent human serum albumin solution.

TABLE VII

Relation of Molecular Shape to Viscosity of Protein Solutions

	Ratio of Axes	Viscosity Coefficient	Relative Viscosity of Solutions	
			6%	25%
	a/b		η/η_0	η/η_0
Water				
Sodium Chloride			1.01	
Glucose		4	1.24	2.7
Serum Albumin:				
Horse	4	6.5	1.39	
Bovine	4	5.4	1.32	5.4
Human	4	5.8	1.35	6.1
Serum Globulin:				
γ Pseudoglobulin (horse)	8	10	1.9	
Fibrinogen	(30)	(70)	(4.3)*	
Serum			1.4	
Plasma			1.5	
Plasma, 4× Concentrated				16.0–26.0
Blood:				
Hematocrit 40			4.5	
Hematocrit 50			6.0	
Hematocrit 60			9.8	

* Fibrinogen is not very soluble in water or in physiological saline. This value is for a 2.2% solution in 0.6 M NaCl.

Indeed, the 25 per cent serum albumin solution is approximately iso-viscous with blood.

Blood substitutes are prepared in concentrated form in the interest of stability, of compactness, or both. When added to the blood stream their concentration is, of course, at once diminished, first by dilution on mixing with the normal or subnormal circulating plasma, then by the hemodilution brought about by the greater osmotic pressure of a concentrated than of an isosmotic protein solution.

In the case of a failing circulation, there may well be an advantage in having the viscosity of the blood substitute as low as possible and the colloid osmotic pressure as high as will not cause hemodilution at too great an expense to critical body fluids. The final judgment as to the concentrations to bring about this optimal response can only be determined by clinical trials under varying conditions of dehydration. It cannot be deduced from the physiology of water and electrolyte balance or from the physical properties of the proteins.

INFLUENCE OF THE NET CHARGE OF PROTEINS ON THE ANALYSIS AND ON THE PROPERTIES OF SOLUTIONS

The globulins would not necessarily exert as great osmotic pressures as the albumins, even were their molecular weights the same. Their isoelectric points are more nearly neutral, and the amount of base they combine at the pH of the blood is smaller per gram, although not necessarily per mole. Thus certain of the globulins, especially those of importance in immunity, have almost neutral isoelectric points. This property, and the high molecular weight aggregates sometimes observed when this fraction is elevated in immunized animals of high antibody content, tempts the teleologist—though guardedly—to wonder whether proteins of this structure cannot give rise to the greatest interactions with other molecules, as in antibody-antigen reactions, with minimal disturbances to the water balance of the body.

The net charge of the globulins at blood pH is a property which is reflected in electrophoretic mobility measurements; though properties of molecules which influence frictional resistance also influence mobility. Tiselius termed the globulins of highest mobility α, those of lowest mobility γ globulins. The great advantage of the electrophoretic method, despite our unsatisfactory theoretical understanding of the phenomenon, is the

FIG. V. Electrophoretic patterns of human plasma and purified fractions.

convenience and elegance of the procedure by which a plasma can be analyzed in terms of these fractions. In the accompanying figure we may compare the electrophoretic diagram of whole human plasma with that of γ and β globulin fractions purified from it. The particular γ-globulin illustrated is rich in antibodies and the β-globulin in thrombin.

TABLE VIII

Electrophoretic Analysis of Plasma Proteins, and Electromotive Force Measurements of their Valence in Blood

	Per cent of Total Protein		Electrophoretic Mobility in Phosphate Buffer pH 7.7 $\Gamma/2 = 0.2$ 0°C.	Negative Net Charge per Molecule pH 7.4	
	in Serum	in Plasma		$\Gamma/2 = 0$	$\Gamma/2 = 0.15$
Serum Albumin:					
Horse, Carbohydrate containing	42		4.5		
Horse, Carbohydrate free			5.3	17	
Bovine, Carbohydrate free	48	40	5.2	12	15
Human, Carbohydrate free	66	62	5.3	15	18
α-Globulin:					
Horse	13		3.9		
Bovine	20	16			
Human	7	7	3.8		
β-Globulin:					
Horse	21		2.9		
Bovine	10	8			
Human	14	13	2.7		
γ-Globulin:					
Horse	24		1.9	7	
Bovine	22	18	1.6		
Human	13	12	0.9		
Fibrinogen:					
Bovine		18	2.1		
Human		6	1.9		

Chemical fractionation combined with electrophoretic mobility measurements reveals more than three globulin components of plasma. Some are euglobulins, some are pseudoglobulins. Many bear prosthetic groups of diverse nature, whose structure and function is still unknown. Many may well be as important because of their specific physiological functions and perhaps because of undiscovered therapeutic uses, as are the globulins concerned with immunity.

Thus far most antibodies have been found to be γ-globulins, although some may have the mobility of β-globulins. Probably in the former group are included the antibodies to mumps and influenza, and indeed to most virus proteins. There is some evidence that the antibody to diphtheria, however, is β-globulin.

Let us turn from the consideration of antibodies to that of a few of the vast number of physiologically important protein plasma constituents that have thus far been concentrated and investigated by physical-chemical means. Thus, among proteins of importance in blood coagulation, thrombin and prothrombin are isoelectric near pH 5.2 and appear to be β-globulins. So is at least one component of the very characteristic blue-green, jelly-like euglobulin (the P_1 of Green), which also has an isoelectric point near pH 5. The so-called "mid-piece" of complement, prepared by Pillemer in our laboratory, also appeared to move in the electric field with the mobility of β-globulin and to be isoelectric between pH 5.2 and 5.4.

On the other hand, the so-called "end-piece" and "4th component" of complement, at least in the guinea pig, appeared to be α-globulin, although separating as isoelectric euglobulin, rich in carbohydrate, near pH 6.3. It is possible that the so-called mucoglobulin of Hewitt, and other carbohydrate and lipoid-rich globulins, are α-globulins. It is the α-globulins which are elevated in febrile conditions, and in lipoid nephroses, in which fibrinogen increases in the plasma as do the α- and β-globulins, whereas the albumins, and to a lesser degree the γ-globulins, are diminished. Conversely, albumin and to some extent γ-globulins are found in lymph, and perhaps in other body fluids, in higher relative concentration than in plasma. It thus would seem that certain of the γ-globulins and albumins leave the bloodstream more readily than do the α or β-globulins.

The protein composition of plasma, and the electrophoretic mobility of each of these crude fractions in a 0.2 molal phosphate buffer at pH 7.7 is given in the accompanying table (Table VIII). So also is the net charge as estimated by electromotive force measurements of those purified fractions that have thus far been studied. With the

exception of a part of the γ-globulin, most proteins are not isoelectric at blood pH, but exist as salts. Indeed, each mole of serum albumin may be considered combined with base, in amount which may be read directly from the titration curve or which is given in the table, both in the presence and in the absence of electrolytes. The electrochemical behavior of these and of other serum proteins is a complex function not only of the size and shape, but also of the net charge of the protein.

INFLUENCE OF THE DISTRIBUTION OF ELECTRIC CHARGES ON PROTEINS

The distribution of the charges on the surface of a molecule has but small effect on the titration curve of a protein with acid and base, or on its electrophoretic mobility. Thus the number of moles of base necessary to titrate a mole of serum albumin from its isoelectric point to pH 7.4 may be taken as 15, in the absence of electrolytes, or as 18 in physiological saline. This valence of the protein, z, is the quantity used in computing the osmotic pressure of the protein at blood pH, the quantity which determines the force which overcomes frictional resistance when the protein is in the electric field of a Tiselius apparatus.

Serum albumin has approximately 100 acid, and 100 titratable basic groups. In the isoelectric condition the molecule thus bears 100 positive and 100 negative electric charges. The negative charges are derived from dissociated carboxyl groups. The positive charges arise from guanidino, amino, and 18 imidazole groups. At pH 7.4, all the carboxyl groups are negatively charged, all the amino groups and all the guanidino groups are positively charged. At the isoelectric point all of the imidazole groups are positively charged, but at pH 7.4 all, or almost all, of them have lost their positive charge. The change in valence of serum albumin, as of most other proteins over the physiological range, is thus in large part ascribable to changes in the charged condition of the imidazole group. For the case of serum albumin about 18 positive charges are lost by imidazole groups, making a total of 82 positive and 100 negative groups per mole. The difference between these values is the net charge.

What are the effects to be expected from the other charged groups? This will depend in large part upon their distribution upon the surface of the molecule. If all the positive charges were at one end of an ellipsoidal molecule and all the negative charges at the other, we should have a very strong electric dipole. Such a dipolar ion orients in an electric field and oscillates in an alternating electric field. The electric frequency necessary for the protein to overcome frictional resistance gives information on the basis of which estimates of the shapes of molecules were deduced. More important is the magnitude of the effect which is measured by the extent to which the oriented protein increases the dielectric constant of the solution.

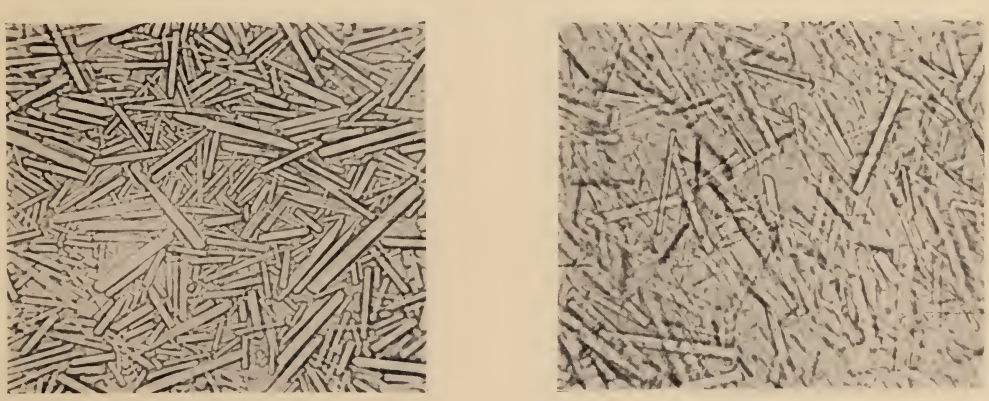

Fig. VI. Microphotographs of albumin crystals. Bovine (left), human (right).

Theoretical considerations suggested, and experimental studies have demonstrated, that the greater this effect of proteins on the dielectric constant, the greater their dipole moments, the greater will their interactions be with salts and with other proteins. Thus, globulins whose solubility is profoundly influenced by neutral salts, have all been found to have high electric moments. Although the specificity of globulins, as antibodies, must depend upon specific spatial configurations of their

amino acid residues, it is not impossible that their functions as immune bodies depend in part upon this greater reactivity of their molecules.

In contrast to the γ-globulin, albumins have the lowest dipole moments thus far investigated. Oncley has estimated the moment of γ-globulin to be approximately 1200 Debye units; of serum albumin approximately 400 Debye units. We must thus conclude that the electrically charged groups of the albumin are arranged in such a way as to approximate electrical symmetry. Such a molecule should react far less than a globulin with other proteins, with neutral salts and with water. It may well be that the very high solubility of the albumins depends upon these same properties.

COMPARISON OF THE PROPERTIES OF HUMAN AND ANIMAL PLASMA PROTEINS

In the preceding discussion we have compared the properties of albumins and globulins, of human and animal origin. The degree to which the properties of human and horse γ serum globulins approximate each other is indeed striking. This is true also if we compare human, horse, and bovine serum albumin. It is true whether our criterion is electrophoretic or ultracentrifugal analysis, is diffusibility or viscosity, valence or osmotic pressure.

And yet no protein of animal origin has ever been found to be identical with the comparable human protein. The differences sometimes detectable in dielectric measurements are often reflected by changes in solubility and crystallizability. Microphotographs of crystallized human and bovine serum albumin are reproduced in the accompanying Figure VI.

Analytical evidence also reveals differences between the distribution of the residues whose spatial configurations presumably result in the species specificity of molecules. The physical-chemical behaviour of analogous proteins is thus often remarkably similar, although the fine structure of the molecules may be different.

In how far, therefore, will it ever be safe to substitute for therapy in man a protein of animal origin? This question can only be answered by clinical trial. Clearly from a physico-chemical point of view it is possible to substitute for a human protein an animal protein which will perform the same physical and physiological functions in nearly the same way. If an animal protein is to be introduced into the human body it should have the property of setting up as few as possible of the reactions to foreign proteins. Globulins, with their higher reactivity, are far less safe from this point of view than albumins. The reactions to albumin containing as little as 0.01% to 0.001% globulin are being carefully investigated, but we are not prepared to discuss the results at this time.

We have attempted to present, however, the point of view guiding the investigations which are in progress. The properties of the diverse molecules which perform the functions of the plasma must form the basis for their rational use as therapeutic agents. All of the plasma proteins, whether of human or of animal origin, can be made available, in concentrated form in any necessary state of purification or modification, and their availability should make possible a new understanding of the functions which they perform in health and disease.

The Coordination of Medical Society Activities*

By MAHLON ASHFORD, M.D.

Executive Secretary, Committee on Medical Education, The New York Academy of Medicine

WHILE the Chairman of your Program Committee has generously assigned to me a subject which will permit me to range the whole field of society activities, I really propose to tell you something of the organization of The New York Academy of Medicine and something of its relationship to the New York County Medical Society, in the hope that you may find from our experience some ideas which will confirm your confidence in your own procedure or which may suggest solutions for pending problems. Of course you will realize that in outlining the work of The New York Academy of Medicine, I have selected that organization because it is the one with which I am familiar. I disclaim any assumption that it has achieved solutions superior to those of your own or of other societies. I particularly stress this point, being aware of the historic seniority of the College of Physicians of Philadelphia, and of the fact that The Philadelphia County Medical Society, like The New York Academy of Medicine, is very close to its centenary.

In reading the interesting account of the College of Physicians, I have been impressed with the remarkable similarities of purpose, organization, and procedure between the Philadelphia and the New York institutions. I have no doubt that we, in New York, have been influenced and perhaps guided by this noble pioneer in the advancement of the science of medicine.

The New York Academy of Medicine is governed by a Council and a Board of Trustees, whose members are Fellows of the Academy. Its principal activities are conducted through standing committees of its Fellows. Of these committees, four may be considered the pillars of the Academy activities—the Library, the Public Health Relations, the Medical Education, and the Medical Information. Each of these four bodies has an Executive Secretary and secretarial staff, and through this device the possible inertia of committee administration is offset. In the instance of the Council and the Board of Trustees, the Director carries out their policies and instructions and he also coordinates the work of the principal committees under the general supervision of the President of the Academy.

The Academy also has a medical journal, the *Bulletin*, whose policies are established by an Editorial Board composed of Academy Fellows; the Editor, who conducts the journal, is also the Executive Secretary of the Committee on Medical Education.

In the following, I shall speak of these several activities with particular thought to their relationship to the New York County Medical Society. The County Society, it may be mentioned, occupies offices in the Academy building and holds its meetings in the Academy halls. Its members, like all other physicians, may use the Academy Library and other facilities, attend scientific sessions of the Academy, and enjoy practically all Academy privileges, save suffrage and holding office. Nevertheless, the County Society is a wholly independent organization. Somewhat like the parliamentary system of Great Britain, the relation of the County Society to the Academy is governed by an unwritten code. Each knows, without written definition, the province of the other. If called upon to define the province of each, I would be inclined to say that the Academy is principally concerned with the elevation of medical practice, the improvement of public health, and the education of the general public in matters relating to medicine. The County, while concerned with all of the foregoing, is perhaps primarily preoccupied with the practical problems of organized medicine and medical practice.

You will no doubt perceive that, while the rôle which I attribute to the Academy may appear a

* Read at the Philadelphia County Medical Society before a joint meeting of the Society and the College, September 23, 1942.

Lectures delivered before joint meetings of the Society and the College during the war, which are available for publication, will be printed in *Philadelphia Medicine*, published by the Society, or in the College's *Transactions & Studies*, or in both, as circumstances may dictate. This paper was printed in *Philadelphia Medicine*, 1942, **38**, no. 11 (October 31).

more lofty one, the problems which are reserved for the County are in many ways far more difficult, more controversial, and more exigent.

Broadly speaking then, all Academy activities are conducted by Committees of its Fellows, each committee having its paid executive and secretarial staff.

THE LIBRARY

The Library of the Academy, as you all know, compares favorably with any medical library in this Country. Its books and periodicals are available to the public and its ample facilities for research render it unnecessary for the New York County or other medical societies of the Metropolitan area to maintain a reference medical library for their members. On the basis of our experience in New York, I judge that a similar arrangement might prove advantageous to the members of your societies.

It may interest you to know that while any physician may use the library of the Academy during public library hours, the privilege of evening hours is reserved for its Fellows, as is the privilege of taking books from the Library. A non-Fellow may obtain these special privileges by paying a moderate fee.

The Secretary of the Library Committee is the Librarian of the Academy.

THE COMMITTEE ON MEDICAL EDUCATION

The functions of this Committee, in general terms, may be said to embrace the original purposes of the Founders of the Academy, for it has to do with nearly every phase of the Founders' objective; *i.e.*, the elevation of the practice of medicine. In fact, it has been proposed that this Committee be re-named "The Committee on Medical Practice and Education."

While this Committee is concerned with all stages of medical education, it is principally occupied with problems relating to the continued medical education of the practitioner. Except in a very limited sense, the Academy does not undertake to conduct courses of instruction. Its function is to survey the entire field of medical education and assist the physician seeking guidance.

As I have said, while the Academy does not conduct courses, it may and does discover deficiencies in opportunity for instruction, and suggests to universities and hospitals the utilization of clinical material to meet such deficiencies. It also notes defects in the quality or character of instruction provided by teaching institutions and suggests indicated correction. It endeavors to catalogue opportunities for postgraduate study in universities and teaching institutions throughout the United States, and especially the opportunities for clinical instruction in the hospitals of New York City, so that the visiting physician from any part of the world may follow with profit the clinical and educational opportunities available in New York City or in any medical center of this country.

In order that physicians visiting New York may be enabled to enjoy the local opportunities for clinical instruction, the Academy publishes a number of bulletins:

The Daily Surgical Bulletin lists surgical operations of 70 approved hospitals which physicians may attend. This listing gives the time and place of operation, the name of the operation, and the operator. This *Bulletin* is mailed each evening to physicians who desire to witness the operations scheduled for the next day. A nominal charge is made for sending this *Daily Bulletin* to the visitors' addresses. This, however, does not by any means cover the expenses of this service, which is one of many contributions made by the Academy to the profession and the public interest. The Committee also publishes a *Bulletin of Approved Non-Operative Clinics in the Medical and in the Surgical Specialties;* and a *Bulletin of Clinical and Pathological Conferences and Special Rounds.* These latter *Bulletins* list clinics in 33 special subjects in 29 general and special hospitals, all of which are open to physicians without charge.

The Committee also publishes a *Daily Bulletin of Meetings, Lectures, Conferences, Hospital Rounds,* and other medical activities of interest to the physician.

The Committee also publishes a semi-monthly folder, listing the programs of all scientific meetings of the Academy and affiliated societies.

This Committee also arranges the scientific programs for the Stated Meetings of the Academy as well as many other lectures for the education of the practising physician.

Perhaps you may be interested to know precisely what meetings the Academy holds during the academic year, from October to May: Two Stated Meetings are held each month. However, the program for the second meeting in each month is arranged and conducted by the Harvey Society, which is an affiliate of the Academy, so that the

Academy itself holds only eight general scientific meetings each year. The Academy, however, has 11 Sections for 10 medical specialties and a Section devoted to Historical and Cultural Medicine; and it also has four affiliated societies, each of which meets monthly. Any of the Sections or Affiliates may arrange joint meetings with the Academy or with each other, or with other societies. This provision, in all likelihood, will be freely exercised during the War period to reduce the number of meetings and to maintain attendance at the meetings which are held.

Each year, the Committee arranges a series of 20 Friday Afternoon Lectures. The lectures take place at four-thirty o'clock and last one hour. The Committee selects outstanding men to present subjects of current interest in a form which will be of practical benefit to general practitioners. Frequently, also, other series of afternoon lectures are given; for example, on Maternal Mortality, a series of six lectures on Modern Methods for the General Practitioner in Meeting Obstetrical Emergencies; on syphilis, a series conforming with the drive instituted by the Federal Public Health Service for the more effective treatment of this old enemy of mankind. In these series of educational lectures, the Academy often enters into joint sponsorship with the New York County Medical Society. In such instances, a joint committee arranges the program and each society takes its share in providing the publicity necessary to secure attendance. Thus, at this moment, the New York Heart Association has proposed that the Academy join with the Association in arranging a series of eight lectures on the Modern Management of Various Forms of Heart Disease. These lectures have a special and timely purpose; that is, the re-education of retired practitioners and specialists who in the present emergency are returning to the general practice of medicine.

It is not unlikely that additional courses of this special character will be instituted. It also appears probable that with the reduction of the number of doctors in civil life, the County and other local societies will more often gather with the Academy in joint meetings.

This year, the Academy will hold its Fifteenth Annual Graduate Fortnight on the subject, "Disorders of the Nervous System." These fortnights are devoted to the complete exposition of a single subject by morning panel discussions, afternoon hospital clinics, evening lectures, and a scientific exhibit which includes fresh pathology, pathological specimens, roentgenograms, charts, photographs, moving pictures, and other modern devices. The purpose is to afford the practitioner, as well as the specialist, an opportunity for a thorough review of the chosen subject. This is the nearest approach which the Academy makes to a formal course of instruction. A registration fee of five dollars is charged to all, save Fellows of the Academy. This is the only Academy activity for which there is a fee. These fees do not meet the expenses of the Fortnight, which usually costs the Academy about $2000 over and above receipts. About 85 per cent of the attendance is from the metropolitan area, but registration usually includes physicians from a score of States and a dozen foreign Countries; at present, chiefly visitors from the Latin American Republics.

This reminds me of a recent enterprise of the Committee, that is, the development of an Inter-America Division with the special object of greeting and assisting physicians from the Latin-American Republics. In pursuit of this undertaking we have formed a relationship with a Spanish language medical journal, which is a modified "Readers Digest of North American Medicine." This arrangement enables the Academy to acquaint the physicians of these republics with the resources of the Academy which are freely offered them, and also provides a Spanish and Portuguese-speaking physician to greet these visitors. Thus far, this enterprise appears to be much appreciated by Latin-American visitors and by the Federal State Department, which is, as you know, committed to the Good Neighbor Policy.

The Committee has a number of other functions, including a consultative relationship to the 11 scientific Sections of the Academy, in such matters as arrangement of programs, but perhaps I have already given you a general idea of the Committee's responsibilities.

The Committee on Medical Education has 30 members, appointed annually by the President of the Academy, with the approval of the Council. In their selection especial consideration is given to interest and accomplishment in medical education, university and hospital representation, and recognition of the medical specialties.

THE COMMITTEE ON PUBLIC HEALTH RELATIONS

Through this Committee the Academy offers medical guidance in community problems. These services are not necessarily confined within the

limits of preventive medicine in its narrower sense but include such broad fields as planning of community resources, the administration of health activities, the selection of personnel for such services, and consideration of medico-legal and medico-sociological problems.

The Committee functions in three different ways. Primarily it acts in an advisory capacity to community representatives when guidance of a medical or public health nature is called for. The Mayor, the Commissioners of the City departments, the Board of Education and the Board of Health, the Governor, the members of the State Legislature, and the Congress of the United States—all have had occasion to seek advice from the Committee. A second function of the Committee consists of the undertaking of surveys and inquiries into existing conditions. And lastly, the Committee acts as an educational body. Through conferences, lectures, and published articles and books it endeavors to focus the attention of the medical profession and the laity alike on the health problems which confront the community and the methods by which they can be resolved.

The Committee consists of 35 members, appointed annually by the President of the Academy, with the approval of the Council. Five members are chosen from among those designated by the medical societies of the counties of New York, Kings, the Bronx, Queens and Westchester from the fellowship of the Academy to act as links between these societies and the Academy activities in the field of medico-social relationships.

The members have all had large experience in the practice of medicine, in hospital work, in teaching institutions, and in libraries. They are equipped, therefore, to look at problems of public health from a somewhat different point of view from that of those who are actively engaged in administrative or practical field work. None of the members is connected officially with any of the branches of the city or state government; the consequent independence of judgment and lack of bias in their deliberations add to the weight of their opinions and actions. Although membership on the Committee entails many hours of hard work, every assignment is accepted willingly. This, I may add, is characteristic of the Academy Fellows, who unfailingly give their services most generously when the Academy calls upon them.

THE COMMITTEE ON MEDICAL INFORMATION

In many organizations, I am sure that this Committee would be designated "Public Relations" or "Press Relations," since it is, in fact, a liaison between the medical profession and the laity, and reaches the public chiefly through the press and radio. The truth of the matter is, I suspect, that when the guiding spirits of the Academy realized the need for this activity, they wisely evaded a powerful conservatism by the use of this innocent terminology. The Academy already had a Bureau of Clinical Information in its Committee on Medical Education. Obviously, the distinction between Medical Information and Clinical Information might puzzle a Philadelphia lawyer, but in the academic family, even the charwomen are able to differentiate.

The path of the Secretary of this Committee is not always an easy one. He must avoid publicizing an individual or an organization, yet must seek to guide the Press so that it in turn will correctly instruct the public. Any one who deals with the Press, particularly the American Press, will appreciate the general indisposition of the Press to guidance on any terms. The governing principle of the Committee in imparting information to the Press is that the public should be given the truth and be saved from falsehood, exaggeration, or misrepresentation. By strict observance of this principle and by maintaining an attitude of readiness to serve, rather than a desire to control, the Academy has in a measure won the confidence of the newspaper men, if it can be truly said that the trust of a New York newspaper man is ever attainable. As a result, it is constantly approached by press-writers, journalists, and authors, who seek an unbiased judgment on medical matters.

In recent years this Committee has also employed the radio as a means to instruct the public. WABC provides each week a 15-minute coast-to-coast period for these talks. As an example of their character, the Committee is now conducting a series of radio talks on problems arising out of war conditions, *i.e.*, talks on nutrition, health maintenance, and prevention of disease.

Upon this Committee falls the task of replying each year to thousands of questions relating to medicine and allied subjects, which are submitted by health organizations, physicians, and the general public.

In a more positive way this Committee arranges

each year a series of lectures by distinguished authorities for the general public. This series, designated, "Lectures to the Laity," consists of eight lectures, one each month from October to May, on medical subjects of current interest. These lectures always have capacity audiences. There is no admission fee. These lectures are subsequently published in book form and are offered for sale at a very moderate price.

This Committee also arranges many other educational lectures for the public, or in some instances for special lay groups, the fundamental idea being to provide accurate and trustworthy information.

WAR PROBLEMS

The organization which I have outlined is essentially antediluvian, that is to say, pre-war. The war has in many senses been tardy in deranging our scheme of things, but we realize that it is about to shatter the present structure, and we must adjust our procedure to new conditions.

In the first place, we expect that ten million Americans will be in the military services within a few months, which means that 50,000 doctors will be withdrawn from civil life; that is to say, more than 60 per cent of the doctors in the active period of professional life. This means, also, that the men who remain to care for more than 90 per cent of the National population, have a tremendous responsibility. I do not suggest that any Governmental agency is indifferent to the welfare of the general civil population, but it is manifest, as well as proper, that the primary objective of the Government in wartime must be the support of the armed forces, and the medical profession must therefore expect a certain disregard by the Government of the problems of civil life and must meet these as best it can.

The great burden thus thrown upon the older members of our profession means, among other things, that there will be a far greater need for the continued education of the ageing and reactivated block of our profession, and at the same time decreased opportunity to conduct this re-education. This decrease in opportunity to conduct post-graduate medical training arises from two sources: the absence in the military service of a high proportion of our more competent instructors; and the inability of the over-worked minority left in practice to find time or strength simultaneously to carry on their practice and attend educational courses and lectures.

Then, it must be borne in mind that the relatively narrow specialization of former years must of necessity be temporarily set aside, to meet the broad and heavy requirement of public need. It may well be that the surgeon, who now performs only the special surgery of his chosen field, may be obliged to resume the practice of general surgery; that the heart or gastroenterologic internist may have to carry on a general practice of medicine.

Finally, we must always remember that civilian populations may at any time be subjected to bombing and chemical warfare.

From the foregoing, it is apparent that three considerations must govern the educational plans of medical associations:

1. That programs be arranged with the primary purpose of assisting reactivated physicians to resume practice on a present-day basis; specialists to undertake general medical or surgical work; and physicians, whose basic and habitual methods date back to the first decade of this unhappy century, to learn the procedures of 1943.

2. That all men in civil practice be taught the present methods of traumatic surgery and the treatment of the casualties arising from chemical warfare.

3. That the value of time to these over-burdened men must be appreciated to the end that our programs be on the target; that the number of meetings be materially reduced by combined or joint programs; that research, theoretical, academic, historical, and cultural programs be, for the time being, subordinated to the mighty task now laid upon our shoulders.

Superstition and Medical Progress in Relation to the War*

By EDWARD B. KRUMBHAAR, M.D.
Professor of Pathology, University of Pennsylvania School of Medicine; President, College of Physicians of Philadelphia

Superstitions are, for the most part, but the shadows of great truths. (Tryon Edwards)

We are all tattooed in our cradles with the beliefs of our tribe; the record may seem superficial, but it is indelible. You cannot educate a man wholly out of the superstitious fears which were implanted in his imagination, no matter how utterly his reason may reject them. (Oliver Wendell Holmes)

"PUT amber beads on the baby's neck to keep him healthy."

"Wear red flannel around the neck for a sore throat" (the virtue being more in the color than the material. In parts of Scotland the flannel must be navy blue).

"The crisis of pneumonia comes on the seventh day."

"If the measles rash strikes in, the baby will die."

"Handling toads makes warts."

"To cure a stye, rub it with a gold ring."

"The night air is bad for you" ("malaria" means literally "bad air"); and "Moonlight causes lunacy."

"Brimstone and molasses keep off spring fever, by purifying the blood."

"A potato (or a horse-chestnut, or a rabbit's foot) in the pocket protects against rheumatism." (In India, it becomes a ring of elephant's hair.)

"A seven-month baby has a better chance to live than an eight-month baby."

"Protect the pregnant mother from alarms, so the baby won't be born with a mark." (This concept of maternal impressions was actually taught by the Professor of Obstetrics under whom I studied, though in many cases we knew the infant deformity must have been produced earlier in pregnancy than the point at which the fright occurred.)

A horrible superstition, prevalent today among the more ignorant Negroes and Italians, is that venereal disease will be cured by intercourse with a healthy virgin.

Near Sanbornton, N. H., you still may be advised to cure the ricketty child by dipping it in Palmer Spring.

I could go on indefinitely with other modern examples of beliefs that have no basis of reason or truth, but with a talk on superstition it seems appropriate to stop at 13. I might interject, however, that of all medical superstitions, the most widespread is that when we are sick, we must take medicine, and usually according to the magic number, three times a day.

We have all heard these sayings, none of which has the slightest basis of fact, and, if we are honest with ourselves, we find that we may even believe some of them.

From the extensive archaeological, theological and medical historical literature on the subject, we can find interesting parallels to these modern superstitions in customs tracing back to the most remote periods. Amulets (from the Arabic "hamlet"—a pendant), like today's amber beads or bags of asafetida, have been used from time immemorial, among the most primitive tribes. The bone buttons of prehistoric skull trephines, Egyptian scarabs, Voodoo scraps of meat of any kind, the "finger of birth strangled babe, ditch-delivered of a drab" of Macbeth's witches, Queen Elizabeth's engraved ring, suspended between her breasts "to expel infectious airs," they all represent the spirit or deity able to ward off disease or disaster, the power of the personality being shared by the representative. Even written charms can share this power. As late as 1731, a formula for warding off plague, to be worn over the heart, is said to have been retained in the official Prussian Dispensatory.

Bits of rope that have hanged a criminal were believed to be efficacious in curing headaches and chills and fever. When my father was Sheriff of Philadelphia around 1890, he regularly got letters asking for such pieces after each hanging.

Today's flannel must be red, and, just as preposterously, it must be red wine that is prescribed

* Lecture for the General Public, The College of Physicians of Philadelphia, March 20, 1942.

for anemia, because both are associated with red blood, the vital fluid. (Beginning with man's earliest paintings, the cave pictures of the prehistoric Cro-Magnons, where magic was invoked for the morrow's successful hunt by depicting the flowing blood of the dying animal, red has been the noble color). For the Chinese red kept away evil spirits, it healed the pustules of small pox in various folklores, and John of Gaddesden is said to have used red trappings to cure the son of Edward II of small pox without leaving a mark. In fact, special significance has been handed down through the centuries to various colors; witness such expressions as "seeing red," "a yellow streak," "true blue," "black hearted."

Why do we still believe in such irrational measures, and, believing them, what right do we have to laugh at the fantastic beliefs of our ancestors or our barbarous collateral relatives?

But I could easily take all the time at my disposal in recounting ancient and modern examples of quaint medical superstitions. It seems more profitable however to consider how and why they have come about, the good and the bad that have come from them, and what can be done to get maximum benefit and minimum damage from them.

The seventh day crisis for pneumonia and the 7-month baby are obvious direct survivors of the mystic numbers of Pythagoras, who had already been preceded at least by the Babylonians, perhaps suggested by their familiarity with the periodicity of the moon and stars. As far back as Roman times, Pliny the elder inquired why we entertain the belief that for every purpose odd numbers are the most effectual. We have lived for thousands of years in a week of seven days, and the seventh son of the seventh son (Scotland, France) is still supposedly endowed with magic powers. It is not always 7, to be sure, though usually odd numbers; in Chinese medicine 5 is a favorite number, 3 and its multiples (t.i.d., 12 hours, 12 months) persist in importance in spite of the advantages of the decimal system, which one would think might have been suggested by our 10 fingers and 10 toes.

First let us define our topic. The word "superstition" (literally, a standing over) is here meant to indicate a credulity about matters beyond human knowledge or control that is irrational or based on insufficient evidence or no evidence at all.

Faith in venerable matters not capable of testing is not to be regarded as superstition. Superstition may be taken as the twin of faith, both springing from man's need to explain inexplicable phenomena. Without going into the many explanations of how superstitions come into existence, one can easily visualize, at least, how primitive man, knowing the cause-and-effect relationship of injury from external causes, seeks to attribute damage of obscure origin to potent but unrecognizable powers. These may be supernatural deities, good spirits or evil demons, or fearsome animals personified, or natural agents such as wind or storm, waving trees, celestial portents. A further step of transferring the supernatural power to representatives of these agencies—animate or inanimate—and we have the foundation for the medicine man, witchcraft, the powers of amulets, talismans, colors, numbers and many of the superstitions that we have been considering. The famous weapon-salve of earlier centuries—through which the wound was healed by anointing the weapon that caused it—depended on the identity of the victim's physical state with that of his blood left on the weapon.

Transference of disease to an animal early became familiar to us in the New Testament tale of the Gadarene swine. Books on the subject tell of many variations of this theme, such as toothache being passed on to a frog by spitting in his mouth. In nearby counties of Pennsylvania today it is said that milk from a sickly infant's feeding bottle is fed to the family cat to hasten the child's recovery. Incidentally, the cat, especially a black one, the favorite of witches, has been especially associated with magic because of its connection with Freya, the most powerful sorceress of Norse mythology. Various parts of the cat's anatomy, for many centuries, were popular items in our ancestors' list of remedies.

With man's sensitiveness to the unusual, it is easy to picture how the child born with a caul, twins, a cripple, especially a humpback, for some reason, an epileptic (the "sacred disease" of the Greeks) might be accepted as the favored of the Gods, and therefore an instrument for performing miraculous cures. The impressiveness of the horrible very probably accounts for the scatological prescriptions that have been popular since the time of the early Egyptians. Cow dung has been given to countless millions of Hindus as a cure for all diseases, because to the Hindu the cow is sacred, and dung, representing the cow's essence, is as potent as the cow herself. But dung has been used for treating disease in many other countries

and times—it is said that in parts of this country today syphilis is treated by burying the patient up to his neck in manure for several days. Human sweat, menses, human or animal excrement, "moss from a dead man's skull" (Leamington Pharmacopeia, 1852), these are but a few of the revolting ingredients that, for one reason or another, have been forced on the sick of all lands and times.

Man's tendency to reason by analogy early led him to use plants that suggested relationship to a given disease or organ—red flowers for anemia, for instance, saffron or dandelion for jaundice, hepatica for liver disorders (witness the name) on account of the resemblance of hepatica leaf to this organ. As such beliefs became strengthened by time, and especially by the support of Paracelsus, they became formulated into a Doctrine of Signatures, which Dan McKenzie defines as follows:—"Every natural substance which possesses any medicinal virtue indicates by an obvious and well marked character the disease for which it is a remedy, or the object for which it can be employed." ("The Infancy of Medicine." London, Macmillan, 1927, p. 162.) Seventeenth century Dispensatories contain many examples of this principle. It reached such extremes, even up to the 19th century, as the plant Euphrasia being recommended for eye diseases because the black spot in the center of its flower resembled the pupil; garlic has a hollow stalk, so it helps affections of the windpipe.

One of the many interesting aspects of archaeological study is that man, regardless of the time or place of his existence on this earth, is found to have customs and beliefs that are remarkably similar to those exhibited by other races in an equivalent stage of culture. It is not that modern savages represent centuries of stagnation, because savage races develop as do the more civilized; but rather that the human mind in a given stage of development reacts to his environment in similar ways. The Indian of our Western Plains, therefore, who was but little influenced by white civilization up to very recent times (1870), revealed primitive medicine in actual operation. He of course believed in spirits, in fetishes, in amulets, in the power of the medicine man, in vile medicines, in purposely painful forms of prescriptions, so that the verse, "Lo, the poor Indian," could well be taken in a very different sense. But these were all consistent deductions from his theory of disease and he also used many treatments that are in good odor in the best of circles today. He used emetics, purges, narcotics, diuretics, and sweat baths, was skilled in the prescription of poisons, wounds, fractures, while his ceremonial therapy was just as logical and impressively suggestive as those we use ourselves. Eric Stone lists 144 drugs used by Indians, 59 of which became additions to the U. S. Pharmacopeia. ("Medicine among the American Indians." N. Y., Hoeber, 1932.)

We cannot trace all of our modern medical superstitions to these primitive reactions that reach back into the mists of antiquity. What mental quirks or chance circumstances are responsible for the establishment and perpetuation of superstitions that cannot be explained in this way? One of the most important, I believe, is the *post* and *propter* fallacy. Something is tried for the patient, and improvement, though it may have had nothing whatever to do with the remedy, is said to be due to it merely because it follows it.

Samuel Pepys was more shrewd than most when he allowed, "I am at a loss to know whether it be my hare's foot which is my preservative, or my taking of a pill of turpentine every morning," though he may well have been wrong on both counts. When we consider the potent and most fortunate *vis medicatrix naturae* of Hippocrates (healing power of nature), we must constantly speculate as to how many remedies merely occupy the patient, while Nature is performing her cure.

The *post* and *propter* fallacy is responsible for so many superstitious medical cults and practices that we cannot pursue them extensively. A few examples must suffice.

In evaluating relatively modern superstitions one must realize that it is difficult even for those more or less conversant with medical history to appreciate the hazy concept of disease that persisted up to the 19th century, when the accumulated knowledge of scientific anatomy and physiology, coupled with the beginnings of the scientific method in pathology and clinical medicine, first permitted rational classifications of diseases and their treatment. We should be ready, then, to be tolerant of systems that hindsight now colors as preposterous. In fact, we must not be surprised at fanciful suggestions being offered today to fill gaps that still exist in proven medical knowledge.

One of the best known medical superstitions in the Western World and persisting well into the 19th century, was the use of the King's Touch for the cure of scrofula—or glandular tuberculosis. A divine attribute, and hence a royal one according to the divine right of kings, but claimed only by the

Kings of France and England, this custom began with Edward the Confessor, and Philip I, his French contemporary, and continued to Charles, the last French king. Though many may have been temporarily helped by it through the power of suggestion, it is hard to see how such a disease could have spontaneously improved enough after such treatment to have kept the custom alive for so long. Perhaps the failures, such as in the case of Samuel Johnson at the hands of Queen Anne, thought it better not to advertise, or blamed the failure on having been touched too late. In any case, we may assume the belief in such a method of treatment could hardly have done other than retard study of the nature of tuberculosis and how to treat it.

Bishop George Berkeley, the learned divine and philosopher, suffered from a complaint which got better after he had taken a course of "Tar Water." This led him to the conclusion that Tar Water was a remedy for all diseases—fevers, coughs, fluxes, hysterics—and even a preventive of small pox. Three books written on the subject by "one of the most learned men of his time" helped to continue the popularity of the remedy, until he died so suddenly that "there was not time enough to stir up a quart of his panacea" (Holmes).

The other, notorious delusion of that time, was the Metallic Tractors, patented in 1796 by Dr. Elisha Perkins of Norwich, Connecticut. At a period when the mysteries of electricity were first seizing the imagination of the public, it was easy to believe that by a kind of galvanized action they could draw out disease of any kind. The Tractors, one of iron and one of brass, though supposed to contain, one copper, zinc and gold, the other silver and platinum, were manufactured at a cost of a shilling a pair, and readily sold for 5 guineas. Perkins' discovery was received enthusiastically here in Philadelphia, and spread rapidly to Europe. George Washington, for instance, bought himself a pair. Incidentally, his diaries show that at one time he paid $25.00 for a visit to a Hex doctor at Lebanon, and at another had an iron ring put on Patcy, his step-daughter, as a cure for fits. Already by 1802, five thousand cures had been reported. Though Elisha was expelled from his Medical Society for quackery, there is some doubt as to his insincerity; there is none, however, as to that of his son, Benjamin, who cashed in as rapidly as possible. Eventually, however, the great English clinician, John Haygarth of Bath, showed that rods of wood produced equally good results, and the process thereafter fell into oblivion. "Tractoration" has its modern counterparts in Abrams' Electronic Dynamizer and Oscilloclast. Some 20 years ago these very expensive instruments were sold to dupes, the one providing a diagnosis of any disease from a drop of blood or even the patient's autograph placed inside it; the other, on the quite unfounded supposition that every disease has its characteristic vibrations, was asserted to cure all disease by breaking down these vibrations. No longer do you hear of Electronic Medicine, but before he died, Abrams is said to have made at least a million dollars. The wonder is, not that quacks find get-rich-quick cures to exploit the people's purses but that there are still so many willing to believe anything that they do not understand.

But my topic is "Superstition and Medical Progress," and thus far we have considered only such superstitions as have interfered with medical progress or with public health. Can superstitions promote medical progress? Yes, though according to our definition, not in a way intended by their promoters. Let us consider Homeopathy and its effect on the main current of medical progress. Samuel Hahnemann, a graduate of Erlangen in 1779, at a time when clinical medicine had little or no scientific basis and when medical theories of the greatest variety were most exuberant, observed that quinine, which cures malaria, as we now know, by killing the plasmodium, could produce malaria-like symptoms. From this, he evolved the famous *Similia similibus curantur* (like cures like). We may agree at the start that this thesis permits discussion in some cases, as in the vaccine treatment of disease, though in most diseases it is a matter of the opposite helping to combat the opposite. Unfortunately for Homeopathic theory, Hahnemann added two more main tenets. One was the theory of "potencies" (which in effect asserted that disease should be treated by increasing dilutions of a substance, even down to a decillionth of a grain of table salt, for example). The other was that psora, or the itch (scabies to us), was the cause of all chronic disease—by no means the only monistic theory of disease proposed in those times, and, as usual, calling for a monistic system of therapy. Such a system of medicine, based almost entirely on fallacies and false reasoning, should have found short shrift even in the infancy of scientific clinical medicine. Why, then, did it flourish for the better part of a century, and actually make a useful contribution to medical

progress? The answer is that regular medicine at that time was suffering from the evils of "shotgun" prescriptions of powerful mixtures given in huge doses. Benjamin Rush's "Thunderbolt," a blasting purge of calomel and senna, was one of the best known of these. In fact, the abuse of calomel (mercurous chloride) made such an impression that the advertisers of many patent medicines still find it desirable to state that they are composed entirely of vegetable compounds. Opposed to this harmful polypharmacy, the minute doses of Homeopathy at least did no harm and allowed Nature better to exert its healing powers. Shotgun prescriptions are no longer the fashion; and Homeopathy by compromising officially, and still more in individual practice on all three of Hahnemann's tenets, has gradually come more and more into line with Regular Medicine, so that today there is little to distinguish between them. Nevertheless, with its contribution now being finished, its schools and number of followers are dwindling and soon will become items of past history.

Another way in which superstitions have contributed to medical progress is by the cultivation of biological truths, even though this were done unwittingly and started from utterly false premises. Consider the medical aspects of Christian Science as the most important of the many cults that treat disease through suggestion. If we leave out such metaphysical questions as whether matter exists at all outside of the mind of the thinker, in a practical world we find it necessary to accept that disease does exist and often kills, as even most Christian Scientists admit. This, of course, is far from asserting that the mind has no influence on the physical state of the body, or denying that, as Janet has observed, equally "vague and absurd utterances have founded cathedrals and comforted millions of men." Anyone with medical training knows that Christian Science healers accomplish their results, consciously or unconsciously, through the power of suggestion, which we now recognize is one of the most powerful weapons of the psychotherapeutic armamentarium. Suggestion, like its equally powerful twin, mental re-education, can help the patient by improving his mental attitude toward physical disease, as well helping mental disease itself; but it may also produce harmful results. Not only may it produce a state of overdependence by the patient on the healer, but also, if it prevents the proper diagnosis and treatment of the physical disease, may even bring about an avoidable fatality. Fortunately most Christian Scientists are glad to call the doctor for physical disease, while others get into legal difficulties, if relatives have died through their failure to call a qualified physician. Our latest cult to profit by the influence of the mind on one's physical condition is psychoanalysis. Founded within the profession by Sigmund Freud, unquestionably an intellect of marked power and originality, psychoanalysis has not been with us long enough for us to know whether or not it is here to stay. It is noteworthy, however, that, as Shryock points out ("Cults and Quackery in American Medical History," *Proc. Middle States Assn. of Hist. of Soc. Sci. Teachers*, 1939), it operates in about the last field of medicine, mental disorder, in which the accurate checks of nosography, pathology, and special diagnostic tests have not yet become available. Unfortunately, the statistical method, comparing test cases and controls, about the only scientific method available, was avoided by Freud and is still almost unused by his followers.

Just as the way for Christian Science healers was left open by the medical profession's belated recognition of the use of psychotherapy, so neglect of some aspects of physical therapy massage, including active and passive motion, was the entering wedge for the cults of which Osteopathy and Chiropraxy are the leaders. Based on utterly false premises, these practices made headway through the benefits that result from more or less (often less) skilfull manipulations, combined with adroit advertising, the utilization of the powers of suggestion, and the human tendency to confuse *post* and *propter* and to try anything in an extremity. If the osteopath and his double, the chiropractor, could only have their practices restricted to those conditions that are helped by manipulations, their chances of doing harm would be greatly reduced. But when an inadequate medical training prevents them from making a proper diagnosis, we must expect them to continue to treat diseases, such as pneumonia, typhoid fever, diphtheria and cancer past their curable stages; worse still, they may even directly kill the patient by converting a carbuncle or an osteomyelitis or a still localized tumor into a rapidly fatal blood-borne affection. We may also group osteopathy and chiropraxy together because it is very difficult to learn the differences in the two theories of disease. According to Andrew Still, the founder of osteopathy, "all the remedies necessary to health are compounded within the human body and can be administered by adjusting the body." Practically, he taught readjustment of

displaced vertebrae which caused disease by interfering with the nerves that emerge from the spinal cord to be distributed throughout the body. Like the homeopath, however, modern osteopaths and chiropractors have extended their doctrines to make "adjustments" in most any part of the body and to use other forms of physical therapy, and even such surgery as the law permits. Chiropraxy, (founded by D. D. Palmer, and firmly established by his son, B. J. Palmer, at Davenport, Iowa), appears also to regard all diseases as due to luxation of the vertebrae which then interfere with the "normal cyclic currents through the nerves." Chiropraxy apparently gives even less training in the fundamental medical sciences and in knowledge of disease than does osteopathy and the process of dog biting dog still continues. In 1927, Fishbein, in his book on the *New Medical Follies*, explained fifty-five of more than a hundred cults founded on some variation of themes such as I have described. Many have doubtless already disappeared in the ensuing 15 years, others may still be brought to mind by window signs seen in a walk down Spruce or Chestnut Streets. Presumably, just as shot-gun prescriptions are now obsolete, when the regular medical profession makes better use of physiotherapy, and the public becomes tired of these cults, they too will disappear.

How are these popular errors related to the present emergency? Chiefly as wastage—wastage of lives, health and dollars at a time when lives and dollars are of more importance to our country than at any other time in its history. To take the less important first, how much money is wasted annually in "patent medicines" and useless forms of treatment that do no good except through the comforting powers of suggestion? This is a question that is obviously impossible to answer with any accuracy, but much more liable to understatement than to exaggeration. By way of illustration, however, we are told that in London the eye quacks alone extract from the gullible public millions of pounds annually. One establishment alone is estimated (by Brewerton) to be taking in $250,000 a year. Shryock quoted from the Arnold letters of a century ago the current report that a "Hygean Vegetable Universal Medicine" brought its owner £80,000 in one year. In this country, careful studies have been made in the past 20 years on the cost of medical care. It was concluded that $360,000,000 were spent annually on patent medicine alone, and that two-thirds of all drugs used by Americans are taken without the physician's order or knowledge. The best sellers, such as Lydia Pinkham's Vegetable Compound, and Father John's Medicine, to be sure, are now forced by law to name their ingredients and not to make impossible claims in their printed advertising. But this at least shows that they contain nothing of value, except perhaps a few simple substances that could be bought at one tenth of the price, and a little alcohol, to cheer the lonely or downhearted soul. For nearly a century these and similar nostrums have extracted millions of dollars from the unsuspecting, gullible public. Even in these days of astronomical war expenditures, these are no inconsiderable figures, and one regretfully ponders over how many bombers and tanks this money might have bought.

An even more serious handicap for our war effort, however, is the uncountable amount of avoidable sickness and death caused by substitution of fake drugs and practices for proper medical treatment. If we could reckon the thousands of dollars now invested in each average American life and the working-day value of each average American, and then calculate the amount lost by resort to medical superstitions, we would surely reach stupendous figures.

It is a universal human trait to seek comfort in the security of dogmatic faith—one has only to consider the comfort that the truly faithful have derived from their religion through the ages—and we must also recognize that in times of great stress people seek all the more for such comfort, and more quickly in new directions when the old has proved unsatisfying. We must guard, then, against increasing urges to superstitious medical practices and we must pay heed to old Isaac Watts, who said that "the child taught to believe any occurrence a good or evil omen, or any day of the week lucky, hath a wide inroad made upon the soundness of his understanding." In the same way, being aware of the powers of suggestion, for harm as well as for good, we must guard against infecting the child with distorted ideas about air raids and the horrors of war. We have recently heard here at this College from one of the highest British authorities that normal children take these horrors as well or better than adults do, even play happily at such games as bombing and rescue parties. It is only the occasional child, who has had inroads made on his understanding by the misplaced protectiveness or emotional talk of nervous parents, who succumbs to these horrors.

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Summary

I hope that I have been able to point out several aspects of medical superstitions that are not without practical significance, as well as being illustrative of a deep-seated emotion that has come down to us from our remote ancestors. True it is that human nature changes but slowly!

I have tried to show that superstition has always, and still does, play an important part in medical matters, due to man's natural desire to be helped in sickness, irrespective of whether the methods used are unfounded, fantastic or even dangerous, according to those who should know most about such matters.

We have considered briefly the mental processes that have developed various medical superstitions, plus the explanations as to why many unwarrantedly hold their ground; also the pitfalls of faulty observation and memory and of wrong diagnosis: the *post versus propter* fallacy, failure to appreciate the tremendous forces of "suggestion" and of "the healing powers of Nature"; the universal tendency to be overimpressed by dazzle, by the dramatic, by the glib talker, by the costly, by the mysterious, and by the forces of tradition.

We have recognized that some cults, though founded on false premises, have contributed not only to relieve human suffering, but also even to the advancement of medical knowledge and practice. We look on the main stream of medical knowledge as the great current receiving tributaries of information from all sources—both clear and muddy—which purifies itself as it proceeds. As Oliver Wendell Holmes pointed out ("Medical Essays," 1883, p. 289), medicine "learned from a monk how to use antimony, from a Jesuit how to cure agues, from a friar how to cut for stone, from a soldier how to treat gout, from a sailor how to keep off scurvy, from a postmaster how to sound the Eustachian tube, from a dairymaid how to prevent small-pox, and from an old market-woman how to catch the itch-insect. It borrowed acupuncture and the moxa from the Japanese heathen, and was taught the use of lobelia by the American savage." Thus, the great corpus of medical knowledge may occasionally derive benefit even from unlikely sources. We must recognize with Francis Bacon that "there is a superstition in avoiding superstition, when men think they do best if they go farthest from the superstition,—by which means they often take away the good as well as the bad."

We have ground for accepting that, even in this enlightened country, employment of superstitious practices results in much preventable sickness and death, and waste of good money. This situation tends to become exaggerated in wartime, when it behooves us to waste *nothing* in our collective effort to bring this country and our civilization safely through this world catastrophe.

I hope, then, that you will feel impelled to help in reducing to a minimum the damage that results from our current medical superstitions.

Rummaging in the Museum

III*

The Dead Chinaman

By JOSEPH McFARLAND, M.D.

Curator of the Mütter Museum, and Fellow, of the College of Physicians of Philadelphia

OBJECTIONS were raised against the collective title of these "lay contributions" from the Museum, first on the ground that it was unnecessary, and second because rummaging was a word thought to imply disorder or carelessness. But if the word "rummage" be looked up in a dictionary, it will be found to mean "to bring forth after a search," and it is in that sense that it is used in the title.

It is true of a museum as it is of a private house, an office, a hospital, or of any other place where many objects are kept and cared for, that although the rule, "a place for everything, and everything in its place," may be punctiliously carried out, some things will inevitably be found for which, for one reason or another, there is no place. Among such are duplicates, dilapidated objects of historic or sentimental value only, and things temporarily stored pending future need, repair or resurrection as antiques. The attic, cellar or storeroom of any old house will serve as an example. A visit to the basement of this College will do the same thing, but I do not advise it.

During the eighty odd years that we have possessed the Mütter Museum it has suffered from a number of vicissitudes. It has been moved several times, and it is frequently said that "two movings are as bad as a fire"; it has been cared for by a number of curators with different ideas of the purposes and uses of a museum and the system of displaying its treasures, and it has also suffered under the provision of its donor, by which ". . . no one shall be permitted to remove from the . . . building . . . any article belonging to the said Mütter Museum. . . ."

If one considers the lapse of time and the number of fragile things that may be broken, corrosive things that may be ruined by rust, fluid preservations whose jars may crack so that the contents dry up, objects of only temporary interest and presented to the museum because the families of the deceased doctors do not know what else to do with them, it will be evident that so large a museum as ours must have accumulated "rummage" of many different kinds. Indeed, many of the closets, and a special room in the basement assigned to the museum, were full of it.

The curators of the past have all been men of professional distinction, whose devotion to the museum is evidenced by the care with which the specimens have been arranged for display in cases, most of which are obsolete in type and incredibly awkward in construction.

The curator has as an auxiliary a "clerk-technician," and as is usual in executive offices, it is the assistant who is best informed as to the details of the business.

It so happened that when the present administration was inaugurated, both the new curator and a new clerk-technician entered their new work at the same time with no more information as to what they had to do or to do with, than the former could learn from an hour's visit to the museum in the company of the resigning curator, and the latter from one day spent with her predecessor.

An old proverb says that "New brooms sweep clean," and we set out to do just that. Not that much dirt was found in the museum, but that after a systematic examination, a great deal of rummage and a good deal of "junk," too miscellaneous and too valueless to be regarded as property, were found.

It was thought advisable to go over the rummage, find out of what it consisted and decide whether or not it should be replaced upon the exhibition shelves or thrown away. It was also suspected that among it might be found some specimens included in the catalogue, but not found where specified. The first task assigned to the

* For the preceding communications in this series see: 1) "A Resurrection of 'Pile': the Peter A. Browne Collection of Hair in the Mütter Museum" (*Transactions & Studies*, December, 1939); 2) "The Petrified Lady" (*Transactions & Studies*, June, 1942).

clerk-technician, therefore, was the finding, classification and temporary orderly arrangement of the rummage in preparation for such decision.

You probably have no idea of the quantity of penetrating black dust with which the railroad and neighboring industries fill the atmosphere of this part of the city, or how it gets into all parts of the building, and into the glass cases in the museum. Perhaps you will realize it, if you look at the adipocere body of the "Petrified Lady" that should be pale gray but is coal black, because it is impossible to clean on account of its fragility, or maybe better when you learn that to keep them as white as you see them, many of the bones in the museum must be washed with soap and water several times each year.

In the basement room to which the rummage had been assigned no attention had been paid to order or cleanliness because no one was supposed to go there. The floor was so covered with crates, boxes, jars, specimens, charts, etc., that there scarcely seemed to be more than standing room. Moreover, the lighting was by one dim old-fashioned carbon electric lamp.

With more lights with modern bulbs rigged up by extension cords, she proceeded with the investigation and itemization, the ultimate purpose of which became more and more definitely the elimination of junk. It was after a few days of this disagreeable and dirty work that the clerk-technician uttered the astonishing statement that is the real starting-point of our story—"*I think the first thing we ought to do is to get rid of that dead Chinaman!*"

"Dead Chinaman. Where is he?"

She led the way to the front wall of the storeroom to a coffin-like wooden box that stood upon the floor, and raising the hinged lid, exposed the contents.

Whether the box had originally been intended to serve as a burial casket or not was difficult to say for it was of the most primitive character, of the cheapest wood, and with meager upholstery. In it, with his head resting upon a pillow of common ticking, comfortably reposed the mummified body of a very small, extremely thin man.

Mummified, but not a mummy. He was not swathed in mummy cloth, there was no fragrant odor of myrrh, cassia and nard and no painted mask covered the face to portray the features as in life. No, it was a nude body, perhaps once injected for anatomical preservation, but now dried to a bony hardness and a dirty dark color. The features, in drying, had retracted, and although the oblique eyes were closed, the retracted lips revealed an unusually perfect set of beautiful white teeth. A glance was sufficient to explain the presence of the body in the museum. There was an enormous scrotal hernia.

The "paraschister" by whom the body had been prepared, had not followed the Egyptian method, but had proceeded along lines appropriate to the case. An incision separating the abdominal wall from the ensiform cartilage to the pubes, and another by which the scrotum was laid open, showed that practically all of the intestines had left the abdomen and descended into the hernial sac. The long period of drying had so changed the intestines into parchment-like lamina of extreme brittleness, that anatomical differentiation into large and small intestines was impossible.

From the open box a disgusting sweetish odor arose and it was with relief that it was shut again.

No number, label, tag or other identification could be found so that there was no other reason for supposing that the body belonged to the museum than that it was found in its storeroom.

But not all of the objects in the room belonged to the museum. There was a great pile of duplicate books that belonged to the library, and a beautiful ship model that belonged to the Assistant Superintendent. To whom did this body belong?

The catalogues of the museum were carefully looked through, and after a lengthy search the clerk was able to point out that one of the original specimens of the Mütter collection, listed as a "plaster cast of an enormous scrotal hernia," was not accounted for.

It seemed improbable that the "dead Chinaman" could be a plaster cast, but it was necessary to be certain, so the box was again opened and a knife quickly confirmed what the eyes and the nose told, that is, that it was no plaster cast, but a dead body.

As both historic and sentimental value attach to any preparation that had once belonged to Dr. Mütter, and as it seemed probable that there still might be some connection between the "dead Chinaman" and the missing plaster cast, final disposition of the matter was delayed pending the judgment of the Museum Committee. But in the meantime employes, officers of the College, and many of the older fellows were questioned with the following result:—

Nobody had ever heard of the "dead Chinaman."

Nobody knew that he was there.

Nobody knew how or when he got there.

As the examination of the rummage proceeded, an array of other useless, offensive and unidentified objects were found—unidentified bones, great ovarian cysts that had been filled with sawdust and dried, but were now cracked open with the sawdust spilling about, cracked jars whose contents of alcohol or formaldehyde had evaporated, leaving once interesting specimens dried to unrecognizable appearance and stony hardness, etc. All of these were set aside for viewing by the Museum Committee in the hope of their final rejection, about which it seemed as though there would be no difficulty as each member had expressed himself in favor of clearing out the "junk," the Chinaman included.

Then came the annual College elections and a new committee, and a professor of anatomy became its chairman. Meticulous conscientiousness in the performance of duty is his predominating quality, so that when the rejection of the assembled junk was proposed, he immediately recalled those words in Dr. Mütter's Deed of Trust, "No one shall be permitted to remove from the College building, except for necessary repairs or preparation, any article belonging to the said Mütter Museum, after the same shall have been deposited there."

As for his own personal opinion, none of it was worth keeping, and all of it ought to be discarded, but he was of the opinion that the permission of the Council of the College should be obtained. The junk was, therefore, allowed to remain until the day of their next meeting, when it was duly inspected, passed upon as valueless and ordered officially to be discarded.

But there was still that clause in the Mütter Deed of Trust: "No one shall be permitted to remove from the building except for necessary repairs or preparation, etc!" There was no thought of either repair or preparation in what was contemplated so it was obviously contrary to the expressed intent of the deed. Should not the opinion of the *juris consultus* be asked? On May 23rd, 1937 he gave the following opinion:

"I do not think that the Mütter Museum Committee should be particularly concerned with the situation that arises in connection with the specimens that, in the course of events, deteriorate and become a nuisance. I can see no reason at all why they should not dispose of such specimens and use the vases for something else. Indeed, I think it would be your duty to do so in order to protect the rest of the collection. I take it that the specimens have not become deteriorated through carelessness in handling them. What has happened is simply one of those things which occur from wear and tear, whether the things that wear out be buildings or furniture or machinery or even human beings."

With this legal advice all was plain sailing, and all of the rubbish soon disappeared; except the "dead Chinaman."

How does one dispose of a dead human body?

If one were to move into a new house, and in cleaning up the cellar find a coffin containing a dead body hidden in a coal bin, how should he proceed? Dismember it and gradually incinerate it in the domestic heater? If unexpectedly observed engaged in this operation, what might the results not be? Dismember it and mix it with the ashes? Discovery would be certain and explanation difficult! No, there must be some orderly legal method of action by means of which one can secure immunity from suspicion and criticism.

The Chairman of the Committee is not only a professor of anatomy, he is also the Secretary of the State Anatomical Board, and in both capacities is accustomed to receive, store and distribute dead bodies. He now came to the rescue, remarking that the next time that he had his car at the College, he would take the body out of the box, put it in the back of the car and take it to the Anatomical Institute to be incinerated before burial according to the rules of the Board, with appropriate religious rites.

"Ah yes," said a bystander, "don't you know that it is illegal to transport a dead body in an automobile?"

"And what would the people on 22nd Street think if they saw you carrying out the dead man, or the people on Clinton Street think when they saw you taking it in?"

"Yes indeed," said a third, "and what would the cop that holds you up in the traffic say when he'd see your rider?"

So the matter was deferred, and an endeavor made to proceed along strictly legal lines. A visit was, therefore, made to the Coroner's office.

Now it has long seemed to many of the wide-awake members of our profession that the office of Coroner is anachronistic and should be abolished. All of its work can undoubtedly be done, and better done, by the police, the district attorney and quali-

fied medical experts employed as needed for the particular cases to be considered. The experience of that visit confirmed this opinion.

The Coroner, himself, was "out", but a deputy listened to the story presented to him in detail, after which he asked why it had been brought to him. Carefully it was explained that it was thought that there might be difficulty in getting rid of the body, and that "if he was willing to release it, he might tell us how to proceed."

"It's none of the Coroner's business," he then said, "it is a matter that belongs to the Board of Heath."

"But what has the Board of Health to do with a dead man found in a cellar? He might have been killed and hidden there."

"I tell you it's only a matter for the Board of Health. Go and tell them about it, and they will tell you what to do."

He rose, and there was nothing to do but obey orders.

At the office of the Board of Health we were politely asked our business, which, when explained, brought out the remarkable assertion that the city Board of Health had nothing to do with such a matter, but that it must be presented to the Pennsylvania Health Department. Why? No explanation, just a mere repetition of the statement.

But how get into communication with the Pennsylvania Health Department, which has its offices in Harrisburg? The Philadelphia office kindly put us into telephonic communication with Harrisburg and the proper official, the matter was again explained, and this astonishing answer was received. "All unclaimed dead bodies belong by law to the State Anatomical Board. Your body, being unclaimed, belongs to it, and to get rid of the body, communicate with its secretary" (whose address he gave us, and who turned out to be also the Chairman of the Mütter Museum Committee). So, the whole matter was for the second time, finally and legally (?) left in his hands.

It had now ceased to be a private matter, so that at a convenient time the State Board undertaker's truck arrived, and the little mummy was removed—unfortunately leaving the smelly coffin behind.

Before closing this account, however, I must ask you to imagine what might have happened, had our chairman, with the mummy on the back seat of his car, driven down Chestnut Street, and somewhere, say about Twelfth Street where the traffic is thickest, met with some slight misadventure for which a "cop" called him down:—

"Are ye blind or only dumb that ye drive through a red light?" Then approaching the car, peering into the window to see who the occupants are, and seeing the corpse—

"Holy Mither, what hev ye got there, a dead man? Don't ye know ye can't be drivin' around with a dead man in yer car? Don't try to explain, ye can tell it to the Sargeant when ye get to the station house!"

How much he would have had to tell!

Memoir of Martha Tracy

By CATHARINE MACFARLANE

MARTHA TRACY, M.D., D.P.H., was the second woman to be admitted to Fellowship in the College of Physicians of Philadelphia. She was born in Plainfield, N. J., on April 10th, 1876. She died in Philadelphia on March 22nd, 1942. The sixty-six years of her life were filled with earnest effort. They were crowned with rare achievement.

Dr. Tracy was the youngest of nine children. Through her mother—Martha Sherman Green Tracy—and also through her father—Jeremiah Evarts Tracy—she was descended from the same colonial ancestor—Roger Sherman—, who had the distinction of being the only man to sign the four great American charters: The Articles of Confederation, The Call of Congress, The Declaration of Independence and The Bill of Rights.

After preliminary education in the Plainfield Seminary for Young Ladies and Children, Dr. Tracy entered Bryn Mawr College with the fixed purpose of preparing herself to study medicine. The list of subjects that she chose for this purpose included Biology, Chemistry, Physics, Mathematics, English, Greek, Philosophy and Economics. In addition to distinguishing herself in this formidable list, Dr. Tracy was Captain of the College basket-ball team for three years and President of the College Athletic Association for one year.

Graduating from Bryn Mawr in the year 1898 with the degree of Bachelor of Arts, Dr. Tracy entered the Woman's Medical College of Pennsylvania. Here, delayed by a year's illness, she reached her goal, receiving the degree of Doctor of Medicine in 1904.

For the next nine years, the research laboratory claimed her. Part of this time she spent with Dr. William B. Coley, cooperating in the development of Coley's Fluid, used in the treatment of sarcoma. In 1907 she gave up the assured future of a research worker in a richly endowed institution, to respond to the call of her struggling Alma Mater, The Woman's Medical College of Pennsylvania. For the next ten years she was connected with the Department of Chemistry in the College, first as Associate Professor under Dr. Henry Leffman, finally as full Professor of Physiological Chemistry.

Keeping step with medical progress, Dr. Tracy found time to acquire the degree of Doctor of Public Health at the University of Pennsylvania in 1917. She gave up her first interest—chemistry—to be appointed Professor of Hygiene at the Woman's Medical College. In 1923 she was appointed Professor of Preventive Medicine in the College, which position she held until 1931.

Also in 1917, upon nomination of the Faculty, Dr. Tracy was appointed Dean of the Woman's Medical College to succeed Dr. Clara Marshall then retiring. As seventh Dean of the Woman's Medical College, Dr. Tracy became an international figure. She filled this unique and strategic position from 1917 to 1940. Her wisdom, her judgment, her serene poise qualified her to evaluate clearly, to decide wisely and to steer the one American medical college controlled by women along a safe and distinguished course.

In 1940, as Dr. Tracy approached the Faculty's retiring age, a call came to serve the City of Philadelphia as Assistant Director of Health under her old friend and colleague, Dr. Hubley R. Owen. With the reluctant consent of the Faculty and Board of Corporators, Dr. Tracy retired as Dean of the Woman's Medical College to enter upon the congenial duties of the Department of Health of this great city. Her outstanding ability, her broad training made her an invaluable member of the Department. She enjoyed every aspect of the work.

Then came Pearl Harbor and the need for Civilian Defense. Dr. Tracy was called upon to address Defense Meetings, night after night, at the end of long days in her office at City Hall. Coming home late one night after a Defense Meeting, Dr. Tracy was chilled. Pneumonia developed. In spite of all that modern medicine could offer, she died on the ninth day.

In a tribute from a fellow Dean we read: "Dean Tracy met with us on an equal footing. We respected her intelligence, her level-headedness, her excellent judgment. Dr. Tracy never promised anything that she could not fulfill."

In a tribute from a former student we read: "Dr. Tracy bequeathed to each one of us who was privileged to be under her leadership, a solid

background of scientific knowledge, a reverence for medical ethics and integrity and a devotion to the high ideals of our profession. Her hand is still upon our shoulders. The legacy of Our Dean is imperishable."

The list of professional societies in which Dr. Tracy held membership is a long one. It includes: The Philadelphia County Medical Society, the Medical Society of the State of Pennsylvania, the American Medical Association, the College of Physicians of Philadelphia, the American College of Physicians, the American Medical Women's Association (of which she was a Past President), the Philadelphia Health Council and Tuberculosis Committee, the Board of Health of Philadelphia, the Association of American Medical Colleges.

A list of her many contributions to medical literature is appended. It begins with "Ye Medical Student's Primer", written in her undergraduate days. It ends with "Safeguarding the Public Health", *Pennsylvania Medical Journal*, 1940.

Not all of Dr. Tracy's life was spent in medicine. For many years she was the center of a large and devoted family of brothers and sisters, nieces and nephews. She was active in the Women's University Club, in the Women's City Club of Philadelphia, and was one time president of the Business and Professional Women's Club of Philadelphia. Her hobby was outdoor life. Her help came from the mountains, where she spent her summers, high up in the Adirondacks, at Rocky Pond Camp.

In closing, I would borrow the words of the President of the American Medical Women's Association, who said, "I pay tribute to Dr. Tracy as a splendid American Citizen. I mourn her loss. I revere her memory."

LIST OF SCIENTIFIC AND OTHER WRITINGS OF MARTHA TRACY

1901. Ye Medical Student's Primer. Phila., privately printed.

1905. (a) Some Micro-chemical Reactions and Their Value in the Study of Cancer Cells. I. Iron. *J. Med. Research*, 1905–6, **14,** 1–12.

(b) Some Micro-chemical Reactions. II. Notes on Methods for the Localizaton of Potassium and Phosphorus. *J. Med. Research*, 1905–6, **14,** 447–454.

1907. (*a*) The Relation of Modern Biochemical Research to Clinical Medicine. *Trans. Alumnae Assoc. Woman's Med. Coll.*, pp. 134–143.

(*b*) A Study of the Toxins of Bacillus Prodigiosus. *J. Med. Research*, **16,** 307–327.

(*c*) (Beebe, S. P., and—) The Treatment of Experimental Tumors with Bacterial Toxins. *J. A. M. A.*, **49,** 1493–1498.

(*d*) (Coley, W. B., and—) Report of a Case of Oidiomycosis. *J. Med. Research*, **16,** 237–250; *also*, *Trans. Am. Surg. Assoc.*, **25,** 386–399.

1909. Analysis of Some Fairmount Park Waters. *J. Franklin Inst.*

1913. (*a*) (-and Clark, E. E.) The Influence of diet upon the Composition of Urine in Normal Individuals. *Trans. Alumnae Assoc. Woman's Med. Coll.*, pp. 136–140; *also*, *Woman's Med. J.*, 1914, **24,** 48–50.

(*b*) (Knox, J. H. M., Jr., and-) A Contribution to our Knowledge of the Excretion of Phosphates in Infancy. *Trans. Alumnae Assoc. Woman's Med. Coll.*, pp. 146–148; *also*, *Am. J. Dis. Children*, 1914, **7,** 409–421.

1914. (-and Clark, E. E.) The Excretion of Creatinine by Normal Women. *J. Biol. Chem.* **19,** 115–117.

1916. (*a*) (Croasdale, C., and-) Do Women Eat Enough? *Trans. Alumnae Assoc. Woman's Med. Coll.*

(*b*) Food and Efficiency. *N. Y. Med. J.*, **104,** 748, 851, 953, 1054, 1149, 1245.

1918–1939. Reports of the Woman's Medical College of Pennsylvania. *Trans. Alumnae Assoc. Woman's Med. Coll.*, 1918–1939.

1919. (*a*) (-and Potter, E. C.) The Woman's Medical College of Pennsylvania; Its Relation to All Women in Medicine. *Woman's Med. J.*, **29,** 202–208.

(*b*) A New Course in Preventive Medicine. *Civic Club Bull.*, pp. 4–6.

1922. Dean of The Woman's Medical College of Pennsylvania. *Trans. Alumnae Assoc. Woman's Med. Coll.*, pp. 90–92.

1926. A Retrospect. Woman's Med. Coll., 75th Anniversary Vol.

1927. (*a*) The Profession of Medicine and Women's Opportunity in This Field. *J. Am. Assoc. Univ. Women*, **21,** 5–10.

(*b*) Women Graduates in Medicine. *Trans. Alumnae Assoc. Woman's Med. Coll.*, pp. 45–53; *also*, *Bull. Assoc. Am. Med. Coll.*, **2,** 21–28.

(c) On Women in Medicine. *Phila. Evening Public Ledger*, Jan. 10.

1928. Uses of Personal Research. In Educational Guidance for Pre-professional Students. *Yearbook*, Nat. Assoc. Deans of Women.

1930. Preventive Medicine. Address in Connection with the Celebration of the Eighty-third Anniversary of the Birth of Anna Howard Shaw. *Bull. Woman's Med. Coll*, **80,** 5–11.

1931. (*a*) Woman's Medical College of Pennsylvania. *Med. Rev. of Rev.*, **37,** 157–161.

(*b*) In Behalf of the Woman's Medical College. *Am. J. Pharm.*, **103,** 137.

1935. The Woman's Medical College of Pennsylvania. A Glimpse at History and a Personal Retrospect. *Bull. Bryn Mawr Alumnae*, May.

1936. The Medical Student of Today. *Club Woman's J.*, Nov.

1938. Greetings. (Address Delivered at a Conference on Opportunities for Women in the Medical Profession and the Selection of Medical Students.) *Bull. Woman's Med. Coll.*, **88,** 4–5.

1940. Safeguarding the Public Health. *Pa. Med. J.*, **43,** 959–961.

College Notes

FELLOWS IN SERVICE*

Resident Fellows

Aronson, Joseph D.
Aronson, Roland Sigurd
Behrend, Albert
Bortz, Edward L.
Bothe, Albert Edward
Brown, Henry P., Jr.
Campbell, Edward H.
Cheleden, John
Cohen, J. Gershon
Collins, Leon Howard, Jr.
Cottrell, James E.
Custer, R. Philip
Cuttle, Tracy D.
Davis, Perk Lee
Deaver, J. Montgomery
Downs, T. McKean
Duncan, Garfield G.
Ellson, J. Vernon
Elsom, Kendall A.
Ferguson, L. Kraeer
Fetter, Ferdinand
Fitz-Hugh, Thomas, Jr.
Flick, John B.
Forrester, James S.
Frazier, William D.
Freeman, Norman E.
Fry, Kenneth E.
Geist, Donald C.
Gibbon, John H., Jr.
Gilman, Robert L.
Gordon, Burgess L.
Gouterman, Joseph I.
Groff, Robert A.
Haines, Harlan F.
Hand, John G.
Hodes, Philip J.
Hunter, Robert J.
Jeffers, William A.
Johnson, Julian
Kern, Richard A.
Keyes, Baldwin L.
Kimbrough, Robert A., Jr.
King, Orville C.
Klemmer, Roland N.
Langner, Paul H., Jr.
Laplace, Louis B.
Leberman, Paul R.
Long, Esmond R.
Lucké, Balduin H. E.
McClenahan, William U.
McDonald, P. Robb
McLaughlin, James S.
Manges, Lewis C., Jr.
Mason, James B.
Meade, Richard H., Jr.
Mecray, Paul M.
Mendell, Theodore, H.
Montgomery, Hugh
Morgan, David R.
Mucklé, Craig W.
Mullen, Edward A.
Nicholson, Jesse T.
Norris, Robert F.
North, John Paul
Orr, Theodore E.
Parker, Alan P.
Pepper, D. Sergeant
Pettit, Horace
Pillsbury, Donald M.
Ravdin, I. S.
Read, Hilton S.
Robbins, Frederick R.
Robertson, Harold F.
Rowntree, Leonard G.
Scheie, Harold G.
Schenck, Harry P.
Schofield, Frederick S.
Scott, T. F. McNair
Shumway, Norman Price
Silcox, Louis E.
Smith, Austin T.
Stengel, Alfred, Jr.
Stiles, Merritt H.
Thompson, Wesley D., Jr.
Uhle, Charles A. W.

* According to information in the files of the College, November 14, 1942. The College office will welcome information concerning omissions or corrections applicable to this list, as well as information concerning the entrance of Fellows into the service subsequent to this date.

Vander Veer, Joseph B.
Waldman, Joseph
Willard, John H.
Winchell, A. Vaughn
Wirts, C. Wilmer, Jr.
Wood, Francis C.

Non-resident Fellows

Braceland, Francis J.
Cooper, Melbourne J.
Hayman, Joseph M., Jr.
Stewart, Sloan G.

THE LIBRARY

The War. Our last packages of Axis-controlled periodicals were received in July following an internment of some months, we gather, in Bermuda. They contained issues of German, Scandinavian, French, Dutch, and Belgian periodicals, a few published in the latter half of 1941, the majority earlier.

We have hopefully enrolled in the Joint Committee on Importations' plan to provide for the receipt in this country, with the government's aid, naturally, of at least one copy of the major Axis-controlled scientific periodicals. Libraries were asked to submit a list of the periodicals deemed essential to their work, the Committee then allocating to each as many of the periodicals on its list as possible, bearing in mind the relative importance of the library's services to its community and the number of copies to be available. Our list comprised abstract and review journals, with the addition of the leading clinical ones. Other medical libraries in this area readily and generously coöperated with us by writing the Committee that they were not accepting the opportunity to submit lists of their own, in the hope that thus our list would be regarded as representing the community's needs —and so the Committee evidently did regard it, because our list was approved *in toto*. Unfortunately, that is the end of the story, for the moment at least (some six weeks before these words become public): none of the periodicals has as yet been received.

The following tale is witness to the fact that even an elderly library can move fast in war-time. One day during the summer, a physician well known to us (though not a Fellow of the College) appeared with the information that he was under orders to sail for China the next day, that he desperately needed to take with him two recent works on tropical medicine which he had tried unsuccessfully in Chicago and all over this city to buy. Could we *possibly* sell him our copies? We did what probably any young library and, we hope, any elderly library would have done: we sold them to him—having in mind, of course, that as recent publications they could easily be replaced. As it happened, one of them, we soon found, had gone out of print almost immediately upon publication. Fortunately, however, it was reprinted shortly after. Under the circumstances, we are inclined to cherish the thought of our 'first editions' helping, in far-away China, to lessen the suffering of her people and of ours.

Acquisitions of Historical Interest. 1. *Scriptores rei militaris*[1]. It is pure coincidence that the library's acquisition of a military incunable, the *Scriptores rei militaris*, occurred in these martial times. The *scriptores* whose treatises comprise the collection—Aelianus, Frontinus, Modestus, Vegetius—are, on the whole, rather vague historical characters. The treatises are not primarily, or even substantially, medical, of course, but the Vegetius in particular is one of the few, scattered original sources of our knowledge of Roman military medical concepts and organization in the early centuries of this era. As an illustration of how even a collection of military treatises need not be entirely out of place in a research medical library, we translate Vegetius' chapter (lib. 3, cap. 2, *Quemadmodum sanitas gubernetur exercitus*) on how to govern an army's health:

> Now I shall speak of a matter that requires especial consideration, namely, how the health of an army is to be protected. That is by sites, water supply, seasons, medicine, exercise.
>
> Let the soldiers not remain in a pestilential region near disease-breeding swamps, nor in arid fields or hills lacking the shade of trees, nor in summer without tents; nor, marching out slowly, let them contract disease from the heat of the sun or the fatigue of the march. But, rather, in summer let them come to a place marked out at the beginning of the march; in bitter winter let them not make their way at night through ice and snow or suffer from lack of wood or insufficient supply of clothing. For a soldier who is compelled to endure cold is safe neither for health or a campaign. And let the army not use pernicious or marshy waters, for

[1](Ed: Philippus Beroaldus). Bologna: Fr. Plato de Benedictis: 1495–6. Klebs 903.3. BMC VI, 828. Sec. Cens. S317.

poisonous drinks of bad water generate pestilence among the soldiers. In this case, sick comrades are to be put in condition again by suitable foods and the skill of the physician. . . . For it goes ill with those on whom lie the necessity of war and disease.

But those skilled in military matters have thought that daily practise of arms is more beneficial to the soldiers' health than are the physicians. And so they have the foot soldiers exercising constantly, under cover when it is raining or snowing, in the fields on other days. Similarly, they order the cavalry to exercise themselves and their horses not only on level ground but on precipitous paths made extremely difficult by open ditches, so that nothing that could happen in the stress of battle would be unknown to them. From which it is perceived how much more assiduously an army should be instructed in the art of arms, since the habit of labor can maintain health in camp and in conflict give victory. If a great force of soldiers remains very long in these places in summer or autumn, destructive disease arises from water-borne contagion and the odor of fetidity, the vitiated drinks, and corrupted air. This can be prevented only by frequent change of camp.

When independent treatises on military medicine and hygiene are lacking—and even when they exist—it can easily be seen how a passage such as this performs a distinct service to medical history. Our edition of these treatises, incidentally, is not to be found in any other American medical library (several have other editions) or in any other Philadelphia library.

2. *Quintuplets Broadside.* Our ever generous friend and Honorary Librarian, Dr. Charles W. Burr, was the donor of an illustrated broadside, printed in German in 1566, recounting the birth of quintuplets. The librarian has published in the November, 1942, issue of the *Annals of Medical History* a brief account and translation, with reproduction, of the broadside. Suffice it therefore to record in these minutes merely the acquisition of this notable piece, which enjoys the distinction of containing the earliest known representation of quintuplets.

3. *Pharmacopoeia Londinensis*, 1632. The first London pharmacopoeia was published by the Royal College of Physicians in 1618. The *Short-title Catalogue* lists five editions printed before 1640; of each of the first three editions it locates only two copies (British Museum and Bodleian); of the fourth, only one complete copy (Bodleian); of the fifth, only one copy (British Museum). This is not to say that numerous other copies are not extant (since the STC circularization of libraries was not very extensive), but it gives some indication of the relative rarity of copies of the early editions of this first British pharmacopoeia. The life of well-thumbed books is usually not very long[2]. We are glad, therefore, to report the acquisition and consequent availability of a well-preserved copy of the 4th edition, 1632, of this famous pharmacopoeia. Quite possibly this and the earlier editions may be represented in other American medical libraries, but this is the earliest edition in our library and neither it nor any of the earlier ones appears to be listed in the Army Medical Library's *Index-catalogue.* Our copy comes, as a bookplate and inscription indicate, from the "Library in the Charity School Chamber in Nottingham given by Dr. William Standfast."

4. *Variorum Tractatus Theologicae de Peste.* Leiden: Joh. Elzevir: 1655. A charmingly bound little Elzevir containing treatises on the plague by four reformist theologians: *Theodorus Beza* (1519–1605), a French follower and biographer of Calvin; *Andreas Rivetus* (1577–1647 or 1651), a Frenchman who became professor of theology at Leiden; and two Netherlanders, Gisbertus Voetius (1589–1676) and Joh. Hoornbeek (1617–1666). These were all eminent ministers and prolific writers; their treatises may doubtless properly be taken as summarizing the Calvinist response to various practical and theoretical questions generated by recurrent epidemics of one sort and another over a period of a century or so. When one recollects how powerfully the views of the clergy have influenced the course of medical progress from time to time, one realizes how advantageous it is to the student of medical history to have at hand a compact little source book such as this Elzevir presents. This acquisition we owe to the generosity of a Fellow of the College, William Drayton, Jr., M.D.

5. *Alia.* From the president of the College, Dr. Krumbhaar, came a first-rate document in the history of anatomy, the original publication of *Lord Warburton's Anatomy Act of 1832*, "which provided that all unclaimed bodies should, under proper conditions, go to the medical schools" (Garrison). By chance at about the same time, Col. William Innes Forbes, at the suggestion of Dr. William N. Bradley, presented a portfolio of documents pertaining to the grave-robbing of Lebanon Cemetery which led to the revision of the legislative act in Pennsylvania legalizing dissection of the human body. The author of the Anatomical Act was

[2] In this instance, a royal proclamation commanded all apothecaries of the realm to follow this pharmacopoeia, and this only. On the *Pharmacopoeia Londinensis* see the appendix to Munk's *Roll of the College of Physicians of London.*

Col. Forbes' father, Dr. William Smith Forbes, and these documents, compiled by the late Dr. Addinell Hewson, were originally his.

Our Fellow Dr. Catharine Macfarlane gave us a Dutch textbook of obstetrics (1820), the *Leerboek der Verloskunde* of H. A. Bake; and from Dr. E. A. Heller came two works of an older generation: 1) a work on scurvy (*Grundliche Beschreibung von Scharbock*), 1704, by Stephan Blankart, who is perhaps best known for his Graeco-Latin dictionary; and 2) an iatro-mechanistic work (*Kranckheit und Artzney des animalischen Lebens*), 1732, by Christianus Democritus (Joh. Conrad Dippel).

In Praise of the Union Library Catalogue. The following story illustrates one of the many services through which the Philadelphia Union Library Catalogue has come to seem an indispensable tool of our work. During the summer there was dug up in the library an uncatalogued copy, without indication of ownership, of one of the four volumes of Christian Wolf's *Elementa Matheseos Universae.* Since we are firm believers in the principle that progress is aided by having books, whenever possible, in the libraries where they would be most used, and since no one would ever think of coming to us for a book on pure mathematics, we queried the ULC as to where the book might be most at home. They reported that the library of the American Philosophical Society was the only one that had this edition of Wolf's work, but that the set lacked one, unspecified, volume. As will be easily guessed, our volume turned out to be the one missing from the Philosophical Society's set. How did the volume come to be in our hands? One of our Fellows, who is also a member of the Philosophical Society, had sent it in with a number of his books of which he was disposing. It stands to reason, of course, that the volume was borrowed from the Society many years ago, since such casual lease-lend arrangements are not engaged in by our important libraries today. But how in the world would this prodigal son have found his way home, had the Union Library Catalogue not been there to point out the way?

THE MÜTTER MUSEUM AND THE COLLEGE COLLECTIONS

The Mütter Museum reports the following acquisitions:

1. A collection of 28 aids to hearing, from the early ear trumpet to the modern acousticon. Presented by Douglas Macfarlan, M.D.

2. Nasal cautery and snare; Tonsil guillotine; Early dental elevator; Vision testing instrument; Atomizer. Presented by Douglas Macfarlan, M.D.

3. Symballophone, known as "Kerr Stethoscope". Presented by the inventor, William J. Kerr, M.D., through Douglas Macfarlan, M.D.

4. Very old microscope, and two boxes of accessories. Presented by Charles C. Norris, M.D.

5. The Barton Cooke Hirst Collection from the University of Pennsylvania: over 100 instruments, 54 of which are obstetrical forceps, most of the rest being other obstetrical instruments; 38 models of pelves and uteri and 11 true pelves. Presented by Mrs. Barton Cooke Hirst.

College Collections acquisitions are as follows:

1. A leather-covered surgeon's box containing surgical instruments. Presented by E. B. Krumbhaar, M.D.

2. Drawings and index of mustard gas, trench foot, and operations. Prepared by Col. Francis M. Caird in France, 1916-1917, and presented to the College in accordance with his wishes by E. B. Krumbhaar, M.D.

3. Silver loving cup presented to Dr. W. L. Atlee by a friend and patient. Presented by Philip Atlee Schaeff.

4. Oil portrait of Charles E. de M. Sajous, M.D., painted by Charles L. Sasportas. Presented by the Estate of Dr. Sajous.

5. Oil portrait of Francis R. Packard, M.D., painted by Justin Pardi. Presented by Dr. Packard at the request of the president of the College.

6. Bronzed plaster bust of W. W. Keen, M.D., by Samuel Murray. Presented by Mrs. Jane Murray.

7. Framed picture of the buildings of the Southern Surgical Association. Presented by Joseph Walsh, M.D.

8. Framed colored photograph of the major faculty of the Medico-Chirurgical College, 1895. Presented by the Class of 1898, through George E. Pfahler, M.D.

9. Edwin Opie brass microscope formerly belonging to Herbert Fox, M.D.; Tissue slides of the original Hodgkin's Disease; Photographs of the original Hodgkin's Disease sections. Presented by Mrs. Herbert Fox.

10. Seventeen British war medals, 1854–1915, complete with campaign ribbons, awarded to members of medical organizations for medical service. Presented by Edward F. Corson, M.D.

11. Ophthalmoscope given to Guy Hinsdale, M.D., by William Osler, M.D. Presented by Dr. Hinsdale through E. B. Krumbhaar, M.D.

TRANSACTIONS & STUDIES

of the

College of Physicians of Philadelphia

Volume 10 (Fourth Series)

Number 4 (February 1943)

The Physiologic Factors Involved in Protecting the Patient against Infection in the Healing of Fractures in Compound Wounds[1]

By H. WINNETT ORR, M.D.

Lincoln, Nebraska

MANY writers on surgery both ancient and modern have referred and even paid a certain amount of deference to nature's capacity for dealing with wounds and infections. But very few surgeons have ever attempted to employ the natural resources of the patient in any consistently systematic way in surgical treatment. This timidity on the part of the surgeon to rely upon the patient for a cure arises out of at least two principal considerations: (1) we still do not understand just how the unaided patient cures himself; and (2) it is usually important for the surgeon to be doing something that either assists or seems to assist the patient to recover. It is in the latter connection that the patient or the doctor is inclined to attribute wrongly certain effects to certain causes in accounting for the patient's progress toward recovery and cure.

In 1923 I published the results of several years experience with a physiologic program for infected wounds, compound fractures and osteomyelitis. The therapeutic factors in surgical care that I called for were (1) immediate restoration and maintenance of anatomic relationship of injured and inflamed parts, (2) open wound drainage of all contaminated or infected areas, (3) protection of wound surfaces by vaseline dressings against mechanical or chemical irritation and secondary infection, (4) immobilization in correct position and rest during surgical operation, after care and convalescence. Thus, for twenty years I have been making a diligent campaign for the systematic use of the patient's own resources in recovery. But even during that time a number of serious distractions have occurred from a general tendency on the part of surgeons to adopt the program I suggested. The first was the Carrel-Dakin method which was in general use when I published my paper as a protest against it in 1923. The Carrel-Dakin method had impressive laboratory and even clinical support but many considerations from the standpoint of either patient or surgeon were entirely overlooked. As I pointed out at that time, any continuous irrigation and frequent dressing method interferes with the reduction of fractures and immobilization. Also there is irritation of wound surfaces and the introduction of mixed infection.

As the popularity of the Carrel-Dakin method declined, there came mercurochrome, maggots, bacteriophage and now the sulfonamids—all involving disturbance of the wound and damage to the patient. In the meantime, we have begun to talk about healing hormones, supposed to begin production elsewhere in the body as a response to muscle or other tissue injury. These, if they exist, are agents which no one has seen, the chemical formula of which is not known, and their modus

[1] Thomas Dent Mütter Lecture LV, The College of Physicians of Philadelphia, December 2, 1942.

operandi we can only guess at from results presumably attributable to them or to other substances—names, composition and whereabouts unknown. Fortunately, there has been no one as yet to manufacture a healing hormone.

We can, if we try, find out a good deal about the conditions under which a patient's resistance to infection and his healing processes operate to the best advantage. This is in the more or less neglected field called by Dr. Flexner "The science of the bedside" or clinical surgery.

Surgeons have often wandered very far from the truly scientific method in their study, analysis of and conclusions from clinical data. Laboratory workers who venture into the clinical field are inclined to forget the rules that govern laboratory research and to confuse observations and speculations when they undertake to relate chemical therapy and the patient's recovery. The entire history of the surgery of compound fractures and infected wounds is replete with mistakes made by surgeons, chemists and bacteriologists in their attempts to decide the relationship of cause and effect in explaining recovery from wound infections, septicemia, septic metastasis, secondary infections and the patient's end result.

Just recently a considerable number of wound infections at Pearl Harbor were treated successfully along the lines which I have been advocating. That is to say, partly intentionally and partly because of the pressure of circumstances, the wounds were treated with a minimum of primary surgery. Only a few wounds were operated upon or closed at once. Nearly all of the wounds were sprinkled with sulfathiazole, injured extremities were splinted promptly and the wounds were infrequently dressed. Many of those sent later from Honolulu to California were still in excellent splints or plaster-of-paris casts, and in good condition. But the manufacturers of the sulfonamids were quick to say (and with some support from surgeons) that such good results were obtained because the wounds had been dusted primarily with sulfanilamide and sulfathiazole. I have it upon the authority of one of the surgeons who saw the patients that the only ones who did badly were those whose wounds were closed early by suturing infected or potentially infected areas. All the rest did very well. Instead of concluding that sulfa-drugs which all the patients had, cured them all, it should have been noted that the ones who did not have complications were those who had open wounds with extremities well immobilized and infrequently dressed. On the contrary, those with similar wounds treated similarly in every other way, except that they were sewed shut, did badly. In other words this experience showed as we should expect that open drainage of the infected wound and rest are, as always, fundamental requirements, and that the sulfonamids failed to exercise their supposed special powers in closed wounds.

The enthusiastic advocates of any chemical wound treatment expose both the patient and the surgeon to two dangers. One is that up to now every chemical method proposed has been inadequate as a cure for wound infection. The other is that confidence in a new chemical leads to a neglect of the fundamental and necessary requirements such as anatomical reposition, drainage, exclusion of infection and rest. These dangers have been illustrated so many times one might suppose that we should always be on our guard when a new chemical cure comes along. The administration and application of the sulfa-drugs in wound infections has already become a fad of such proportions that surgeons are relying upon these drugs to bring about a cure and are neglecting other essentials in surgical care.

In a recent circular from the Bureau of Medicine and Surgery, Navy Department, April, 1942, immobilization of wounds and infected parts is mentioned, debridement and drainage are discussed, but irrigation of wounds is still permitted and reliance for a cure rests chiefly, as far as these official instructions are concerned, upon the sulfa-drugs. In eleven pages in the circular on wounds and burns, the sulfa-drugs are mentioned on every page, employed for every type of wound and injured part, and in the eleven pages of the circular are mentioned thirty-nine times; ten times oftener than any other drug. The very great danger of poisoning by sulfa-drugs is barely referred to.

When Dr. Baer advocated the use of maggots in the treatment of wounds and compound fractures, he and many other good surgeons were carried away in the same manner. Dr. Baer, in his first paper on the subject, said for example: "In cases which had had chronic osteomyelitis for from four to ten years and had been operated upon from two to fifteen times, we took the case and without any sterilization, without any gloves, without washing up the skin, absolutely denying ourselves all chemical reagents for the sterilization of the skin or the wound, we cut down on that wound and took out whatever sequestra we could find in the wound itself. . . . Then next day . . . we introduced as

many maggots . . . as that wound would hold. The end of the fourth day we washed . . . those maggots from the wound. Then we inserted another group of maggots . . . every fourth day until the end of the sixth or seventh week. At the end of that time, all those wounds were healed. We have had some twenty-one cases both of compound fractures and ordinary chronic osteomyelitis . . . and we have yet to have any one of those twenty-one cases fail to heal".[2] Yet the maggot method was simply another in the long list of frequent dressing, mixed infection, and otherwise disturbing surgical technique that entirely failed to bring us the cures that were promised or, in fact, any assistance in the treatment of these cases. A final report only three years later on the maggot method showed that in 94 of Dr. Baer's own cases only about 45% were healed, and the method has now deservedly fallen into disrepute.

I have made a selection from the medical literature of your own city (Philadelphia) to show how easily a good surgeon may be induced to forget his fundamentals of surgery, physiology and even logic. I quote from Dr. T. S. K. Morton[3] just 50 years ago. Note the similarity to what is being said about the sulfonamids at the moment:

During the past six months I have been employing acetanilid locally in a large number of surgical affections, with results so surprising in some respects as to make it difficult to restrain enthusiasm in commenting upon the antiseptic properties of the drug.

. . . I think myself justified in making some preliminary observations that others may be persuaded to try the drug, so that, by multiplying observers and cases, we may more early come to know the exact value and limitations of the drug as an antiseptic.

The action of acetanilid upon wounds, especially granulations, when used in full strength, is to produce intense dryness, blueness, and to check at once and prevent the formation of pus. Upon extensive granulating surfaces and chronic ulcers a slight burning sensation is at first perceived, which is rapidly succeeded by a sedative or anesthetic effect. If used in sufficient quantity, a thin scab of acetanilid, combined with the wound secretions, forms, under which healing rapidly progresses. If a very large surface is exposed to the action of the undiluted drug, toxic symptoms promptly supervene in susceptible individuals. It is probable that children and the aged are more sensitive to its absorption than are vigorous, middle-aged persons . . .

I have found that all ordinary suppuration ceases in the presence of acetanilid, even when much diluted, in a manner equally astonishing and gratifying. Abscess cavities, boils, and carbuncles, when opened, and dirty, greasy wounds, produced by machinery or upon the street, have healed as a rule, without further suppuration, and in an unprecedentedly short time after acetanilid has been applied in the form either of pure powder, gauze, ointment, or dissolved in alcohol, water, or oil, as an injection. Sloughing septic lesions have been trimmed up, dusted with acetanilid, and sutured without drainage, yet have frequently healed by primary union. Clean wounds have been likewise freely dusted and sutured, and have healed similarly, thus proving that the drug does not interfere with healing in the absence of sepsis. So slight is the secretion of wounds so treated that many extensive ones have been healed under the collodion scab . . .

Suppurating joints freely dusted with the drug after opening have ceased to form pus, and under subsequent packing of the wounds with acetanilid gauze have healed with excellent functional results. In acetanilid I believe that we have the safest dressing to ward off the infection of joints subsequent to operation through wounds, persistent fistulas, etc. It would appear that pus microbes cannot exist in the presence of the drug, and that skin bacteria do not multiply in its proximity . . .

I have seen much to lead to the belief that in acetanilid we have at last found a substance which will either destroy or render inactive the normal bacteria of the skin by its absorption into and through the epidermis. A few facts point likewise toward the possibility of controlling certain inflammations of the lymphatics and superficial tissues by contact with the drug during absorption from the surface into the economy.

Possibly we may be able to render operative fields sterile, even of the skin bacteria, by the previous local application of acetanilid. Should this prove practicable, then we can operate with what has never before been secured—an absolutely sterile skin . . .

Another point of great importance, still being misunderstood both in and out of the bacteriologic laboratories and the operating theater, is that of wound contamination by air. The great Lister demonstrated to his own satisfaction that attempts to sterilize air by a carbolic acid spray were unnecessary. After using the spray for some years, he abandoned it and expressed regret that he had overestimated its importance. Certainly Lister reduced the number of living organisms in the atmosphere by his use of a steam spray containing

[2] Baer, W. S.: Sacro-iliac joint—arthritis deformans. Viable antiseptic in chronic osteomyelitis. Proc. (1929) Interst. Postgrad. M. A. North America, *5*: 365–372, 1930.

[3] Acetanilid as an antiseptic; with observations upon its use in one thousand surgical cases. Phila. Polyclinic, *4*: 61–4, 1895.

carbolic acid; but, he was able to recognize the fact that fingers, instruments and dressings were more likely to carry infection into wounds than that the relatively small number of bacteria in any atmosphere should fall into operative fields and be the cause of "septic mischief". For a proper appreciation of the scientific problem involved in a study of atmospheric contamination, one might read the experiments reported by one of the founders of modern chemistry, Lavoisier. His technical methods in the study of sea water, water from the river Seine and rain water and the effects upon these of distillation might serve as a guide to our thinking about germs and infection in the air. Lavoisier showed us how to distil even polluted water and prove that it was fit for chemical study and chemical research. He demonstrated by a series of observations, in which all the factors could be known exactly, that the amount of foreign material in any kind of water was so small and the effect of distillation upon the water so great that a single distillation was adequate for even the finest kind of chemical research. Not so with the medical scientist. Some experimental work has indeed been done on the atmosphere, but conclusions from such study have been different and conclusions very differently arrived at from those truly scientific experiments and deductions by Lavoisier.

With so many factors unknown and no possibility of exact determination of the physiologic factors involved we can only infer that whether we breathe germs, swallow them, or infect our wounds from the atmosphere, we can and usually do defend ourselves against all atmospheric kinds and amounts of infection. And this is true whether the air or we ourselves are treated chemically or not. It has indeed been shown that we can remove substantial quantities of living organisms and mechanical substances by sterilization or filtration. Such particles may cause infections, allergic reactions or mechanical irritations if in sufficient quantity, but as a rule the number of germs left is too small to affect the results of breathing, eating or surgical procedures conducted under otherwise normal hygienic and operating theater conditions.

Such additional refinements as X-ray, Violet Ray and other electrical expedients in attempts to sterilize the atmosphere suggest "painting the lily" as long as we have sunlight, ordinary home or hospital hygiene, and operating theater surgical asepsis as our allies.

A difficulty that always arises in trying to decide what it is that makes a wound infection better or worse is that we have as yet no way of determining the chemical quality of the physiologic process and healing reactions involved or the value of the most important factor of all, the patient's ability to resist infection. Recently, however, we have had a most important contribution to this subject. Barnes and Trueta at Oxford last year demonstrated the importance of the lymph flow in distributing toxins and infection from an extremity to the remainder of the patient's system. They showed that doses of toxin, snake venom or even infectious organisms so large as to kill the patient promptly under ordinary conditions might be borne successfully if the infectious or toxic material could be isolated even temporarily in an extremity by ligating the lymphatics or even by immobilizing the extremity in a plaster-of-paris cast. By arresting the lymph flow, the patient was able to deal successfully with the smaller amounts of the infectious or toxic material carried by the retarded lymph flow into the general circulation and over the longer period resist otherwise fatal amounts of such material. The work of Barnes and Trueta completely rationalizes the claims we have been making for many years as to the greater ability of the patient to resist infection if we provide conditions that ensure wound drainage, protection of the wound surface against infection and afford physiologic rest. It is under such conditions that the individual with a wound or fracture can deal successfully with inflammatory and toxic difficulties in amounts that would be fatal or cause septic metastasis and a continuing septicemia otherwise.

These observations call attention also to the importance of conserving the patient's resources in every way. They indicate clearly that it is a fallacy to suggest that a patient who is promptly restored to correct position, whose wound is left open, and who is well immobilized during the early stages of his injury or infection recovers because of a powder sprinkled on the wound at the first dressing. This is an obvious violation of the scientific method. Besides, it deprives the patient of the credit due him for having resisted the infection healed the wound and in large part having made his own recovery under conditions to which his surgeon may, or may not, have made a substantial contribution.

The value of arresting the lymph flow in protecting the patient against systemic distribution of toxin or septicemic infection is thus shown to be both direct and indirect. The amount and viru

lence of the toxaemia and septicemia are reduced and he is given time to organize and utilize his defenses. That pain, fever, and shock are all diminished and the processes of recovery and repair facilitated has now been demonstrated many times by clinical observations as conclusive scientifically as any series of experiments in the laboratory. Lives are saved during the early hours of severe local inflammations and time gained to set up both local and general defenses.

The effects of slowing up local lymphatic circulation may also suggest a different interpretation of the observations of Lister upon inflammation before 1865.

Lister was among the first to observe that in the early stages of local inflammation, the arteries dilate, the capillaries become engorged and finally the circulation of the entire area is slowed up. He did not discover the migration of the leucocytes nor did he observe the phagocytic action of the white blood cells. But how much better off are we now in explaining the disappearance of germs in an inflammatory area. We are still not sure, clinically, whether or not the germs are food for the phagocytes, whether the white cells dissolve the germs in their own interior or kill germs in their vicinity or whether we must eventually find a chemical agent that will kill infection without poisoning us as we have tried so hard to do.

Nor does it help us very much, if we incline to rely upon chemotherapy, to assume that there are healing hormones that respond from somewhere to injury or infection. We can not now reconcile these with any chemical treatment, e.g. sulfathiazole. When there is local thrombosis and disintegration, we can only admit defeat and disintegration of forces we do not understand mobilized presumably to overcome bacterial invasion.

Occasionally, a patient has sufficient influence with his surgeon so that his instinct enables him to contribute more to his recovery than he would be permitted to do otherwise. A classic example of this is in the story of the royal patient treated by Ambroise Paré. When the great Paré was called to see this patient, he found him lying on a cot with an old gun-shot wound of the hip severely infected and draining into his bed for a long time so that the patient was terribly soiled, very sick and in great pain, but, after all, resisting both his injury and his infection with a degree of success. It had been proposed many times to remove him to a clean bed and better surroundings. This the patient had refused; under Paré's care, without movement and with simple dressings, but provided with cleaner surroundings, better food and finally even with music and cheerful entertainment, the patient got well.

One of the wound and infection cures proposed upon the best possible laboratory and scientific authority and from which it took us several years to recover was mercurochrome. As early as in 1931, Rockwell of Cincinnati pointed out, however, that it was quite impossible to inject enough mercurochrome to have any germicidal effect upon the patient, that there was danger of mercurial poisoning and that if there were any beneficial results from this chemical they must be due to physiologic reactions or responses which were still imperfectly understood.[4] Rockwell suggested dehydration as an explanation of benefits following intra venous mercurochrome, but pointed out that this and other physiologic reactions might more safely be obtained by other means. In the same communication Rockwell called attention to the supposed selective action of several similar chemicals but preferred supportive and defensive measures for the patient such as had been suggested by Dr. Martin Fischer. Several of Dr. Fischer's contributions to physiologic defense as a measure to combat wound and systemic infection are entitled to much more consideration than they have received.

Any review of the literature of wound treatment, before or after the period of Lister, reveals the inadequacy of any antiseptic wound treatment that has been tried up to this time.

We are not at all justified in calling sulfa-drug administration and application modern treatment. Identical methods and even similar drugs are described in thousands of pages of medical literature before and since the days of Pasteur and Lister. In 1864, for example, Lister treated a patient with pyemia with ten grain doses of sulphite of potash every two hours—and this dosage was doubled on the sixth day—but the patient died.

To suggest that the sulfonamides, so popular just now, are more specific, more efficient or more trustworthy than their thousands of predecessors or to give them credit for the benefits accruing from the open wound, infrequent dressing method, is to misunderstand the role of the patient himself and his defense against infection. The results claimed for wound antiseptics may be obtained regularly without them if the surgical fundamentals of drain-

[4] Rockwell, George E.: "Streptococci Blood Stream Infection," New York, Macmillan, 1931.

age, prevention of infection, rest in correct position and general care of the patient are always observed.

The one constant factor and one which is commonly lost sight of in the recovery of all these patients (whether chemicals help or hinder him) *is the patient himself.* Now that we know more about the influence of blood supply, the role of the nerves in preventing trophic changes, and the importance of the lymphatic circulation in localizing infection at the point of the wound or in the injured extremity, it is obvious that if we can reduce an extremity with an extensive wound or fracture to correct length, position and anatomic relationship, if we can provide adequate drainage for the wound and if we can reduce the amount of infection in such wounds to a minimum, all at the first dressing, then we have put the patient in the best possible condition for his own defense and one in which he is most likely to recover. Whether-or-not any chemical agent for wound treatment can affect this situation very much is open to some question; but we did learn from Lister that a suitable germicide will help us to exclude infection. My own choice is tincture of iodine. That wound surfaces as well as skin surfaces are safer for the protection of the patient if they are sterilized superficially at the first operation can hardly be doubted. But to carry wound surface treatment, whether by chemical or by debridement, to the point of extensive trauma seems as absurd as to carry the preparation of the skin to the deeper layers in order to do away with all the surface organisms before a surgical operation. Let us carry out well known physiologic principles, certainly, in dealing with these patients and forget about some of the obviously absurd techniques and claims put forward for the sulfonamides and other chemotherapeutic agents.

It has long been a teaching of good surgeons that no secondary operation is to be done upon a compound fracture until the fracture and wound area has been healed for sometime. Some surgeons have insisted even that such a scar or fracture area should be massaged for two or three weeks to make sure that infection would not be lighted up as a result of manipulation before any operation should be undertaken.

I have been saying for a long time that whether-or-not infection recurs in such scars, depends upon two points. First, whether-or-not the wound area, if active or latent infection is present, is adequately drained following an operative procedure and second, whether-or-not the extremity involved is thoroughly protected against muscle spasm, movement and other kinds of irritation following the operation. A recent case illustrates this point. L. W., news writer and radio commentator on duty in Greece, was injured by a machine gun bullet from a German plane. He sustained a severe compound fracture of the right thigh. He was treated in a village in Greece for a short time, then in Athens where he tried to persuade his surgeons to use the immobilization and infrequent dressing method. With this method he himself had become familiar while on duty in Barcelona. He was unable to obtain this kind of care until he came by way of Lisbon to New York. After several drainage operations, his osteomyelitis of the femur healed, but he still had an angular deformity in the upper third of the femur with about an inch and a half of shortening of the limb. There was also an internal rotation of the thigh and leg below the point of fracture and a sciatic paralysis with an equinovarus deformity of the foot. He asked his surgeons to perform an immediate osteotomy for correction of the deformity, but they urged him to wait until the limb had been healed for a year before undertaking this secondary procedure. When I saw him his wound in the back of the thigh had been healed about two weeks. I told him there was no reason why he should not have his osteotomy and have the deformity corrected, with his foot brought into correct position immediately, if the post-operative care could be strictly carried out.

This man came to Lincoln on June 12, 1942 and on June 17 an osteotomy was done through the angulation in the upper third of the femur. Two skeletal pins were put into the proximal fragment of the femur and one through the lower end as the limb was rather easily pulled down to correct length and position. The foot was partly corrected at the time of the operation and his range of knee motion was increased by about fifty percent to beyond an angle of ninety degrees. A double leg plaster-of-paris cast with crossbars was put on. He had no symptoms of irritation, muscle spasm, or infection following his operation. In fact, he had very little pain.

Further improvement in the position of the foot was obtained by a turnbuckle inserted into the outer side of the foot and the cast and the foot gradually brought up to a position of moderate dorsi-flexion and eversion. His operative wound and the fracture were soundly healed in 8 weeks, at which time (August 13) he began walking with crutches and a caliper splint. He left the Hospital to return to New York on August 30th. There

were no complications at any time and he is now walking on a straight leg. There is less than one-half inch shortening and he walks well in an ordinary shoe with no extension. It is expected that complete return of power to the tibialis anticus group of muscles may be obtained and that knee motion and strength will continue to improve for some time.

As an illustration of wound healing in one of the more serious kinds of infection, I should like to describe a recent case with osteomyelitis of the sacro-iliac joint. This young man is a Nebraska farmer who has been disabled for about three years. He did not come under my care until August 6, 1942. During 1940 and 1941 he had a draining sinus in his left groin. The source of this drainage had not been determined up to that time, but he thought the trouble was in his hip. When the draining opening closed for a few days, he became very stiff and lame in the left hip and leg and sometimes had an elevation of temperature. At the time of our examination, the sinus had been closed for several months. His pain and disability were still moderately severe, however, and he was incapacitated for any real farm work. Both his physical signs and our x-ray led us at once to the left sacro-iliac joint. There was considerable damage in the joint itself but no destruction of the ilium or the sacrum in the vicinity.

I felt that he had a quiescent suppurative arthritis of the sacro-iliac or a mixed infection tuberculous affair which had become stationary. He accepted my advice for an arthrodesis of the affected joint. At operation, August 12, 1942, I first chiseled off the entire iliac side of the articulation. As I lifted out this piece of bone, about two ounces of yellow pus came up into the wound. In spite of this, I took off the sacral side of the joint, then packed the wound wide open with a large vaseline pack. He was put into an extensive double spica plaster-of-paris cast. He was dressed on September 16, 1942, and was sent home for one month. Because of rapid gain in weight he returned on September 28 for a new cast, and had a dressing and went home on crutches in a single spica cast. On November first this cast was taken off. He was soundly healed both front and back and has been walking about since that time in a posterior hip splint.

I report this illustrative case in some detail because the pelvis, hip, and shoulder are the most difficult regions in which to get this kind of healing. They are the most difficult to immobilize and in adult patients the most difficult to control otherwise. But we have now had several hundred such cases with eighty or eighty-five per cent of recoveries. We now have about thirty-five cases with sound healing after resection of the necrotic head of the femur. The secret of success in these cases is drainage and rest with all the diseased parts in as favorable relationship as possible for repair. Rigid control of the affected parts—such as can scarcely be obtained, except with plaster-of-paris—is necessary. It is the duty of the surgeon to protect the patient even against himself. We have made at least this one step forward from the apparatus of Thomas of Liverpool—and that is not by "improved splints" but skeletal fixation and fixed traction in plaster-of-paris casts.

Even so, as I look at the devices manufactured and recommended for maintaining length and immobilization in our day, I have felt that Thomas was justified when he remarked on one occasion: "Some surgeons admire my splints as though I were a blacksmith. But the principles upon which they are constructed, they will never see". And we should remember, also, that Thomas' dictum regarding tuberculous joint disease has now been shown to apply to acute and chronic compound injuries and infections of all kinds. And that is that the most important factor in treatment is "rest; enforced, uninterrupted and prolonged".

Warhafftige Beschreibung einer newen Wundergeburt/ welche an ort vnd enden/ wie hernach genennet sich begeben hat.

ANNO M. D. LXVI.

IN einem Dorff zwischen Augspurg vñ Dilligen/ auff halben weg/ von yedem deren ort vngefärlich drey meil wegs gelegen/ mit namen Emersacker weylandt des Edlen vnnd gestrengen Herren Vlrichs von Knöringen Ritters/ nachgelaßnen Sönen vnderworffen/ vnnd zügehörig/ hat sich auff den XXII. vnd XXIII. tag December jüngst verschines LXV. Jars zügetragen/ das eines armen Bauren Weib/ mit namen Anna Risin/ Caspar Risen/ daselbstē wonhafft Eheliche Haußfraw/ fünff lebendiger Kindlein welch ganz volkomenlich/ vnd an allen gliedmassen ganz gewesen/ geboren/ vnd auff erden gebracht/ Als nämlich auff Sontag vor dem Christag/ zů abends hat sie ein Knäblein/ so vngefärlich zwo stund gelebt/ erzeuget. Folgens an dem heyligen abent der geburt Christi/ hat sie noch ein Son sampt dreyen Töchterlein/ vñ also in zweyen tagen fünff vnderschidlicher lebendiger Kinder geboren. Nach dem aber bemelte newgeborne Kindlein etwas sehr schwach gewesen/ seind sie also nach altem Christlichem brauch/ also mit eylin dem Hauß geaufft/ vngefärlich zwo stund gelebt/ vnnd nach irem absterben/ zů der erden/ wie gebreüchlich bestattet worden. Die gezeügen der wunderbarlichen geburt/ so selbstē darbey/ vnd gegenwertig gewesen/ von der Oberkeit deßhalben seind examiniert worden/ seind dise. Erstlich die Heham heist vnd wirt genant Hilaria Bützin/ die geuatter Anna Gangenriederin/ auch Anna Oertlein/ Vögtin daselbst. Item/ Agatha Kratzeren/ vnd andere vil Personen mehr/ welche all genůgsam anzeigung diser sachen halber gethan. Es ist auch zů mercken/ das obbestimptes Weib/ zů vor auch durch ein Geburt drey Kinder auff Erden gebracht hab.

Was nun der Allmechtig Gott/ durch solche vnd andere wunderbarliche schickungen/ vns zůuerstehn will gebē ist nichts schließlichs/ oder Endtliches darvon zů schreiben. Doch ist da neben wol zů wünschen/ ja fleissig zů flöhen/ vnd zů bitten/ das er durch sein Götteliche Gnad vnd Allmechtigkeit/ solche seine wunderwerck/ in welchen wir jhn allzeit loben vnd preisen sollen/ vns zů rechter betrachtung seiner Göttlichen Mayestatt in warer bekantnuß vnsers Christlichē Glaubens/ vñ erhaltung seiner Gebott/ allzeit zů gůtem komen laß/ durch das verdienst seines eingebornē Sons/ vnsers Erlösers vnd Seligmachers Jesu Christi/ der mit jm vñ dem heilgen Geist/ Regieret von ewigkeit zů Ewigkeit/ Amen.

¶ Getruckt zů Strasburg bey Thiebolt Berger am Wynmarckt.

QUINTUPLETS BROADSIDE OF 1566

Reproduced from the original in the Library of the College of Physicians of Philadelphia

An Illustrated Broadside of 1566 Announcing the Birth of Quintuplets*

By W. B. McDANIEL, 2D

Librarian, The College of Physicians of Philadelphia

SINCE the Mesdemoiselles Dionne continue through their personal charm to maintain the interest of a wide public in the subject of quintuplets, and since this form of *Geburtswunder* is uncommon enough usually to engage the attention of even the most blasé obstetrician, there seems to be ample justification for the library of the College of Physicians of Philadelphia to share with the historically minded medical and lay public an extremely rare and interesting sixteenth century quintuplets broadside which has recently been presented to the library by its Honorary Librarian and exceptionally generous friend, Dr Charles W. Burr.

Histories of obstetrics and of pediatrics do not devote as much attention to the subject of plural births as one might expect, while such births have been perhaps unduly exploited by the lay press—and presumably for the same reason: their relative scarcity, especially on the ascending scale. Few art representations of quintuplets, for instance, are to be found in the medico-historical literature. Doubtless the best known of these is an often-reproduced genre painting of Dutch quintuplets born in 1719.[1] Schlieben reproduces a photograph of a gravestone (eighteenth century?) at Lommatsch, in Saxony, depicting quintuplets walking hand in hand.[2] Fehr has reproduced the pictorial upper half of a colored copy (Zürich) of our broadside (apparently the only other recorded copy), which may very well be the earliest extant representation of a quintuple birth.[3]

The broadside, the edges of which are rather roughly cut, measures approximately 12¼ inches in height by 9¼ inches in width. As it is likely that anyone interested in the woodcut would be interested in (but loath to come to grips with) the florid, tautological German text, I append a translation, though I fear it does scant justice to the original.[4] However, the main facts regarding the birth and untimely death of Herr and Frau Rise's quintuplets can perhaps more easily be deduced in this way. The reader will not fail to note, at the conclusion, the concept of the wonder-birth as a divine manifestation of enigmatic import, as well as the cautious hope that such miracles will lead men to a just recognition of the divine prowess. Not unusually, and not unnaturally, wonder-births were regarded in, and even considerably beyond, this period as punishment for sins of adultery or bestiality.[5] It may be surmised that this explains why such care is usually taken, in broadsides of this sort, to establish for the woman an impeccable marital status.

* This communication is reproduced, with permission and a few slight changes, from the *Annals of Medical History*, 3.ser., **4**, 450–2, November, 1942. The *Transactions & Studies*' general policy of not accepting communications that have appeared, or that are scheduled to appear, in other periodicals covered by the medical indexes is waived only in cases, such as this, in which the communication might be thought to be of particular interest to the Fellows of the College.

[1] Reproduced by A. Bastin, *Aesculape*, (n.s.) 1929, **19**, 296; Schlieben[2], and several others.

[2] E. Schlieben, *Z. f. ärztl. Fortbildung*, 1936, **33**, 264.

[3] Hans Fehr. Massenkunst im 16. Jahrhundert. (Denkmale der Volkskunst, hrsg. v. Wilhelm Fraenger. 1. Band.) Berlin, 1924. Bild 47, which is very briefly summarized on p. 105. Mr. William H. Schab, New York, from whom our broadside was bought, kindly loaned me his copy of this work. The broadside is reproduced in Mr. Schab's *Catalogue No. 5*. p. 51.

[4] The translation would be worse than it is, had not the following friendly associates happened in and been pressed for advice as to the probable meaning of this or that word or phrase: Dr. Edward B. Krumbhaar, Dr. Samuel X. Radbill, Miss Sallie H. Todd, Mrs. Edith S. Moore.

[5] Bastin, *loc. cit.*, p. 290.

True Description of a Recent Wonder-birth Which Occurred at the Place and Under the Circumstances Hereinafter Named

1566

[Woodcut]

In a village situated half-way between Augsburg and Dillingen, about three miles from each, Emersacker by name, formerly subject and belonging to the posthumous sons of Master Ulrich von Knöringen, knight, it came about that on the 22d and 23d day of December of the 65th year just passed, Anna Rise, the wife of a poor peasant, Caspar Rise, dwelling in that place, a married housewife, gave birth to and was delivered of five living infants who were entirely complete and possessed of all the members. Namely, on the Sunday before Christmas, in the evening, she was delivered of a little boy, who lived about two hours. Subsequently, on the holy eve of Christ's birth, she gave birth to another son together with three little daughters, and thus, in two days, to five separate living children. But inasmuch as the aforesaid new-born children were very feeble, they were hastily baptized at home, following the Christian custom, and lived about two hours. After their death they were buried in the ground, as usual. The witnesses of the prodigious birth, who were themselves present and in attendance, were therefore examined by the chief magistrate. They are: first, the midwife, called and named, Hilaria Bützin; the godmother, Anna Gaugenriederin; also Anna Oertlein, magistrate's wife of that place; also Agatha Kratzeren and many more persons, all of whom gave competent information in connection with this case. It is also to be remarked that the above-designated woman previously also had been delivered of three children at one birth.

What now the Almighty God wishes to give us to understand through such and other wonderful dispensations, there is nothing final or conclusive thereon to write. For all that, it is well to wish—even diligently to implore and to pray—that, through His divine grace and omnipotence, He permit such wonder-works of His, in which we shall ever praise and commend Him, always to aid us to a just consideration of His divine majesty in true acknowledgement of our Christian faith and observance of His commands, through the merit of His only-begotten Son, our Redeemer and Savior, Jesus Christ, who with Him and the Holy Spirit reigns world without end.

Printed at Strassburg by Thiebold Berger at the Winemarket.

Memoir of Herbert Fox[1]

By BALDUIN LUCKÉ

DR. HERBERT FOX, Professor of Comparative Pathology in the University of Pennsylvania, Director of the Penrose Laboratory of Comparative Pathology of the Philadelphia Zoological Society, and of the Pepper Laboratory of Clinical Medicine, died in the University Hospital, on Friday, February 27, 1942, in the 62d year of his life. He had been ill for some months and finally succumbed to coronary thrombosis.

Herbert Fox was born in Atlantic City on June 3, 1880, the son of Samuel Tucker Fox and Hannah Freas Fox. He received his early education at the Central High School in Philadelphia, and at the youthful age of 21 was granted his Doctor's Degree in Medicine by the University. The following two years he served as an interne at the Philadelphia General Hospital, and the Presbyterian Hospital of this City. By this time he had selected pathology as his career, and after holding some minor positions, he felt the need for further formal training and went to Vienna, then a center for the study of pathology. Here he remained during 1905 and 1906, working chiefly under Albrecht, who recognized his ability by making him second assistant. Upon his return to Philadelphia, Dr. Fox found his opportunity. He became Pathologist to the Laboratory of Comparative Pathology which is maintained by the Zoological Society at its Gardens. This was the beginning of what became his foremost professional interest, and from this Laboratory originated his most significant contributions to pathology. Here, for 36 years, until his death, he spent approximately one half of his working time. An account of the man would be empty without an account of this unique laboratory, the first of its kind in the country, and still, perhaps, the foremost in the world.

The Philadelphia Zoological Society, founded in 1859, has maintained since 1872 a fine collection of animals for public exhibition. In November 1901, the Society created a laboratory for the purpose of conducting post-mortem examinations on animals dying at the Gardens. Now was fulfilled the true purpose of a menagerie so aptly forecast by Sir Francis Bacon in his *New Atlantis:* "We have also parks and enclosures of all sorts, of beasts and birds; which we use not only for view and rareness but likewise for dissection and trial, that thereby we may take light what may be wrought upon the body of man". The new laboratory was at first placed under the direction of the late Dr. C. Y. White, who served until 1906. In these early years the growth of the venture was slow. The laboratory had no quarters of its own, no adequate funds were available, there was no trained technical help, and only the most important specimens were subjected to complete postmortem examinations. In 1905, however, a suitable building was provided, and, shortly afterwards, Dr. Fox, just returned from abroad, became the Director. Under his guidance the laboratory grew rapidly. Funds became available, which though never adequate, did permit the Director to have technical assistance. Autopsies and histopathologic examinations were now performed on all dead mammals, birds and the larger reptiles. Within a few years, Dr. Fred D. Weidman and Dr. E. P. Corson-White joined the Staff, and morphological studies were supplemented by bacteriologic, parasitologic and metabolic investigations. Work went on apace. The first publication from the new institute appeared in 1909. The paper, prepared jointly by Drs. White and Fox, dealt with "Results of Tuberculin Tests In Monkeys". It was a timely subject, for tuberculosis then was very prevalent in the monkey colony, and caused great loss. The authors demonstrated the practical value of the tuberculin test as a diagnostic method. Animals found to be tuberculous were strictly isolated and new arrivals were held in rigid quarantine until tests had shown them to be non-tuberculous. Within a few years, tuberculosis, from being the chief cause of death among monkeys, became a rarity. Thus, from the very beginning, Dr. Fox concerned himself especially with the studies of diseases that had their counterpart in man; "That thereby we may take light what may be wrought upon the body of man". Bacon's words were his favorite quotation and he was convinced of their truth. There followed papers on neoplasms, on

[1] Read before The College of Physicians of Philadelphia, December 2, 1942.

the comparative pathology of the thyroid, on cirrhosis, on pancreatic disease and on diseases of the heart. These and other studies were expanded into a book published in 1923 as "Diseases in Captive Wild Animals and Birds. Incidence, Description, Comparison". This is the first systematic monograph dealing with the pathology of the various groups of mammals and birds. The book is based upon approximately 6000 postmortem examinations. It contains a wealth of information on the reaction of the various zoological orders to pathologic agencies. That the animals did not live under strictly natural conditions does not detract from the great value of the observations; indeed it introduces certain experimental features: the effect of captivity, of certain diets, the relation to many disease processes of the substantial prolongation of life that sheltered existence brings. Throughout the text he compares and contrasts the lesions observed in a wide variety of animals and birds with similar lesions in man. He was fully aware that observations of this kind might have a direct and practical application in explaining certain pathologic states in domestic animals and man. While his main interests lay in morphologic pathology, he realized that the experimental pathologist might find the records of the Gardens useful in his work. To quote Dr. Fox: "For example, he may learn that rodents are not prominent among the orders showing spontaneous arteriosclerosis; and that primates have a good cardiac reserve while marsupials have not. Too often experimental work is not based upon facts including natural probabilities."

In more recent years, Dr. Fox's studies were embodied in two other important monographs: one on arteriosclerosis in wild animals and birds, the other on chronic arthritis in wild mammals. In the former he showed that lesions comparable to arteriosclerosis in man occur in wild animals, and that while the degree and form of arteriosclerosis are subject to many modifications through the various orders of animals, the general pathologic processes are essentially the same. He also pointed out important differences between arterial diseases of mammals and of birds, and expressed his belief that the solution of the basis for this difference may be expected to lead to a solution of some of the major problems of human arteriosclerosis.

Dr. Fox's latest work, on arthritis, was published three years ago. It was based upon a study of more than 1700 skeletons and autopsies of wild animals. His studies revealed joint-changes that correspond closely with certain forms of arthritis in man. The type of arthritis he encountered most often was chronic osteoarthritis. He found no apparent relationship between arthritis and taxonomic position, zoogeography, ecology, habits, diet, general pathologic states, and focal infections; but he did find correlation with body build and form of locomotion. This monograph is beautifully illustrated by many photographs and will long remain a monument to his scholarship and industry.

In this appraisal of Herbert Fox's achievements, I have stressed his work in comparative pathology. There is, perhaps, no more neglected branch of the biological sciences than this. Despite the brilliant success with which physiology has used the comparative method, pathology has all but neglected it. Indeed, too often, comparative pathology has meant nothing more than veterinary pathology. General physiology, the science dealing with functions common to living things in general, was founded on comparative physiology; a truly general pathology can exist only when a secure basis is established by comparative pathology. In this field, Herbert Fox was a distinguished pioneer. His University recognized his services by naming him, in 1927, Professor of Comparative Pathology.

Dr. Fox did not confine his work to the laboratory in the Zoological Gardens. For over thirty years he divided his interests between this laboratory and the Pepper Laboratory of Clinical Medicine at the University; in 1911 he succeeded the late Dr. Alfred Stengel as Director of this institution. Like the Penrose Laboratory, the Pepper Laboratory is the first laboratory of its kind in this country. It signified the first attempt to establish a thoroughly equipped laboratory for investigative and routine work in close connection with a University medical clinic. Conceived by Provost William Pepper and built in 1895, it has been an example for countless laboratories since established.

In the Pepper Laboratory, Dr. Fox came in daily contact with problems of human pathology. He gradually brought together a large and competent staff. Though much of his time was occupied by administrative and routine duties, for he kept himself thoroughly informed of the manifold activities, he yet was able to make a number of important contributions, particularly in the field of the lymphatic diseases. He collaborated with Dr. Stengel in several editions of their well known "Textbook of Pathology," and he wrote an "Elementary Bacteriology and Parasitology for the Use of Nurses"

which has gone through five editions. Perhaps his greatest contribution to the laboratory and to the medical clinic was the intangibles that came through the close association of a broadly trained pathologist and a corps of able clinicians.

Dr. Fox's connection with the Penrose and Pepper Laboratories was interrupted by two years of the World War, when he served with the rank of Major as Chief of the Laboratory at the Cantonment Hospital of Camp Zachary Taylor, near Louisville, Kentucky. To his efficiency and high sense of duty the writer of these lines, who served in his Command, can testify with admiration and affection that the years have strengthened. Major Fox was not satisfied with routine work done well; he insisted that scientific information which might be of value to the Service be recorded. Much of his scanty spare time was spent in gathering data of medico-military interest. Thus he published a "History of Measles at Camp Zachary Taylor, Kentucky, Summer of 1917 to Winter of 1919." It is a masterly survey of an extensive epidemic. When it appeared in the *Military Surgeon* it was accompanied by the following note by the Editor: "This is the first of a series of selections from definitive contributions to the Medical History of the War which will be printed from time to time in *The Military Surgeon*. These publications will be selected from the great mass of historical material, with an eye to their extrinsic importance and value to medical officers of the Services."

Dr. Fox was a member of a number of learned societies, among them The American Philosophical Society, The Academy of Natural Sciences, and the Association of Pathologists and Bacteriologists. He was elected a Fellow of this College on May 6, 1908, and served as a member of the Alvarenga Prize Committee during the years of 1924 and 1925. In 1926 he was elected a member of the Committee on the Mütter Museum and College Collections and served on this committee until the end of 1938. During 1923 to 1925 and during 1935 to 1938 he was a member of Council. For forty years he was a member of the Philadelphia Pathological Society, serving as Vice President in 1916 and as President in 1917.

Dr. Fox had a happy life. He was keenly interested in his work, he had a host of friends, and his family ties were close. In 1904 he married Louise Carr Gaskell, a lady of great beauty and charm, who died in 1933. Of their three children two survive, Margaret Fox Hentz and Samuel Tucker Fox, 3d; both his son and son-in-law are in the Armed Forces. In 1938 he married Mary Harlan Rhoads, who survives him.

Personally, Herbert Fox was of medium height and somewhat stocky build. He was smooth shaven and had prominent eyes. His expression at work was often stern, and, like many men of achievement, he had moody periods. He considered his laboratory staff a large family, shared their joys and troubles, and always at Christmas gathered them together for the singing of carols and other jollities. His sense of humor was keen, his mind judicial, and those who sought his advice knew that he would give the closest attention to their problems. At his home he was a rare host; at play, a delightful companion; at all times, a courteous, gallant gentleman.

Transactions of the Sections

SECTION ON GENERAL MEDICINE

Special Meeting, September 28, 1942[1]

Meeting, November 23, 1942[2]

THE USE OF OUABAIN IN RAPID CARDIAC ARRHYTHMIAS. William G. Leaman, Jr., M.D., and William I. Gefter,* M.D.

SPECIFIC SUBSTANCES IN THE URINE FROM LEUKEMIA PATIENTS. F. R. Miller,* M.D., and D. T. Turner.*

THE CEREBRAL DISTURBANCES AS EARLY MANIFESTATIONS OF THE RHEUMATIC STATES, WITH REPORT OF FIVE CASES. George C. Griffith, M.D., and Joseph C. Yaskin, M.D.

RECENT STUDIES ON THE 'VIRAL' PNEUMONIAS. Hobart A. Reimann, M.D., and Allison H. Price,* M.D.

SECTION ON MEDICAL HISTORY[3]

SECTION ON OPHTHALMOLOGY[4]

Meeting, October 15, 1942

POSTERIOR PHLYCTENULAR KERATITIS: CASE REPORT. Glen G. Gibson, M.D.

THE ETIOLOGIC ROLE OF FOCAL INFECTION IN DISEASES OF THE EYE. Meyer Solis-Cohen, M.D.

CLASSIFICATION OF CONGENITAL PTOSIS. Edmund B. Spaeth, M.D.

Meeting, November 19, 1942

THE STORY OF ASTHENOPIA. THE IMPORTANT PART PLAYED BY PHILADELPHIA. WHAT OF THE PRESENT AND THE FUTURE? (The Fifth Annual de Schweinitz Lecture). Walter B. Lancaster,* M.D.

Meeting, December 17, 1942[5]

EDWARD JACKSON, M.D., A FOUNDER OF THE SECTION.[6] Burton Chance, M.D.

MEMOIR OF LUTHER C. PETER, M.D. Edmund B. Spaeth, M.D.

MEMOIR OF WILLIAM T. SHOEMAKER, M.D. William Zentmayer, M.D.

LIPEMIA RETINALIS. M. Luther Kauffman, M.D.

AN UNUSUAL CASE OF BIRTH INJURY OF THE EYE. F. H. Adler, M.D., and E. Gerard Smith,* M.D.

SECTION ON OTOLARYNGOLOGY[7]

Meeting, October 21, 1942[8]

REPORT OF A CASE OF GIANT CELL TUMOR OF MAXILLARY ANTRUM (NON-MALIGNANT). Arthur J. Wagers, M.D.

SARCOMA OF THE TONSIL, WITH REPORT OF SEVEN CASES. C. A. Whitcomb,* M.D.

RESOLUTION ON THE DEATH OF CURTIS C. EVES, M.D. George B. Wood, M.D.

Meeting, November 18, 1942[8]

ORBITAL CELLULITIS. Horace J. Williams, M.D.

THE RESPONSE OF THE LABYRINTHINE APPARATUS TO ELECTRICAL STIMULATION. E. A. Spiegel, M.D., and N. Scala.*

REPORT OF A CASE OF LYMPHO-EPITHELIOMA OF THE NASO-PHARYNX. Abraham H. Persky,* M.D.

Meeting, December 16, 1942[8]

BASAL CELL LESIONS OF THE NOSE AND OF THE LIP. Warren B. Davis, M.D.

THE ROLE OF RHINOPLASTY IN THE RESTORATION OF NASAL FUNCTION. Romeo A. Luongo, M.D.

* Not a Fellow of the College.

[1] Organization meeting necessitated by the absence of the regular officers on active service.

[2] Joint meeting with the Section on Internal Medicine of The Philadelphia County Medical Society.

[3] Meetings of this Section will not be held during the war.

[4] The transactions of this Section are customarily abstracted in the *American Journal of Ophthalmology* and the *Archives of Ophthalmology*.

[5] Joint Meeting with the Eye Section of The Philadelphia County Medical Society.

[6] To be printed in the April, 1943, number of the *Transactions & Studies*.

[7] The transactions of this Section are customarily abstracted in the *Archives of Otolaryngology*.

[8] Joint meeting with the Philadelphia Laryngological Society.

SECTION ON PUBLIC HEALTH, PREVENTIVE AND INDUSTRIAL MEDICINE

Meeting, November 16, 1942[9]

Introductory Remarks by Commander G. B. Tayloe* (MC), U.S.N., and Major C. J. Morosini (MC), U.S.A.

Tuberculosis in the Navy. Lt. Commander George W. Pillmore* (MC), U.S.N. (Commentators: Capt. J. G. Whildin* (MC), U.S.A., and Lt. Commander J. Joseph Hennessy* (MC), U.S.N.)

[9] Joint meeting with the Section on General and Industrial Surgery and Industrial Health of The Philadelphia County Medical Society.

Tuberculosis in Industry. Charles Francis Long, M.D. (Commentator: Walter H. Lindsey, M.D.)

Meeting, December 7, 1942[9]

A HEALTH PROGRAM FOR NURSES' TRAINING SCHOOLS

The Health Program at the Philadelphia General Hospital. Albert H. Domm,* M.D.

Prevention, Detection and Management of Pulmonary Tuberculosis among Student Nurses. David A. Cooper, M.D.

A Dental Survey of Student Nurses by Means of the Bite Wing Film. John H. Arnett, M.D., David A. Sampson,* M.D., and Thomas M. Meloy,* D.D.S.

Personality Problems in Student Nurses. Earl D. Bond, M.D.

President's Address[1]

By EDWARD B. KRUMBHAAR, M.D.

THE College and its Fellows are fully carrying out their obligations to our Country in its war effort. The record will, I believe, compare favorably with that of similar institutions in the country. As an institution, our war activity is necessarily not a conspicuous one. To be sure, our library purchases have been considerably changed by the pressing needs of the war effort, and a section of easily viewed works connected with the war has been established in the Ashhurst room. The topics of our scientific meetings have been chosen with war needs in mind. Our facilities and resources have been freely offered to Army and Navy medical officers in our vicinity. Adapting to the reduction in the number of civilian medical men in city and country and to transportation difficulties, we have arranged a number of joint meetings with guest speakers mostly from nearby.

But more important to the war effort than what we can do as an institution is the contribution of our Fellows, both as individuals and as members of units formed before the war. Not to be forgotten are those remaining behind with their increased responsibilities of private practice, teaching, and hospital work. Willy nilly, we are all affected by the changes necessitated and we can take proper pride in those who have stepped forward voluntarily to assume the extra burdens. I can only refer in general terms to those who, in addition to taking over the practices or institutional duties of colleagues on active service, have volunteered for civilian defense work, draftee examinations, Procurement and Assignment, N.R.C. and O.S.R.D. tasks, teaching in special courses for Army and Navy medical officers, and so on.

We already have records, incomplete I am sure, of 100 Fellows who are on active service with the armed forces. It is no secret that H. P. Brown's Pennsylvania Hospital unit has long been in New Caledonia; R. A. Kern's Navy Specialty unit is, or was, in the Pacific on the U.S.S. "Solace"; George Wagoner's and E. L. Bortz's similar units have been at their stations for months; the 20th General unit, recruited from the University Hospital, which awaited activation in Louisiana since May, the 24th Station Hospital, an offspring of the 20th General, formerly at Indiantown Gap, and the 38th General Hospital (Jefferson) have all reached the stages of A.P.O. addresses.

A list of those who we have learned are on active service appeared in the December, 1942, number of our *Transactions & Studies*. We shall be grateful for any other names, as we are anxious to have a complete list of those Fellows who have joined the Armed Forces.

With the war service disposed of, the rest of my report is of less importance. However, there are a number of matters of interest to those who have the welfare of the College at heart that should be considered briefly at this time.

Notwithstanding the necessary pre-occupation with the war in the past 12 months, the affairs of the College have progressed surprisingly well, except financially. Here unavoidable circumstances, chiefly the loss of two-thirds of the dues of those on active service, and the lowered rental of the 13th and Locust Streets property as an outdoor parking space, have reduced our income by more than $5,000. As you will see in the Treasurer's Report, an anticipated balance of $1912 in the past year's budget became a deficit of $1750. The Council has recommended for the present year a budget that already anticipates a deficit of $940, which will probably be more before the end of the year. However, it was felt that as this was due to temporary circumstances, and as we have fluid funds which more than cover this amount, it would be better to accept the deficit for at least another year, rather than to cut to the point where the College property might suffer or be endangered, with the additional risk of losing valuable assistants. Our Treasurer, Dr. Flick, having resigned to go on active service last summer, Dr. Starr has acted as Treasurer as well as Chairman of the Finance Committee for the rest of the year.

Our scientific lectures were of unusually good quality. With the implication of the war effort in mind, we decided first to arrange lectures through the spring only. These were given as follows: in January, our Non-resident Fellow Dr. John H. Musser gave the first lecture of the Benjamin Musser Lectureship (founded by his father, John H. Musser), on "The Heart that is Ageing." The

[1] Read at the Business Meeting of the College, January 13, 1943.

Hatfield Lecture in February was given by Professor C. M. McCay, of Cornell, on "Nutrition, Ageing and Longevity." In March, Réné Dubos, of the Rockefeller Institute, told, in the 50th Newbold Lecture, of his and Rollin D. Hotchkiss' remarkable work on "The Origin, Nature and Properties of Gramicidin and Tyrocidine." Dr. Bock's Anders Lecture in April was on "Fatigue," as studied in the Harvard Fatigue Laboratory. The last address of the season (a Mary Scott Newbold Lecture), by C. Sidney Burwell, Dean of the Harvard Medical School, reported "Studies of the Circulation in Congenital Affections of the Heart and Their Application to Some of the Problems of Heart Disease." For the subsequent lectures, in view of the expectancy of smaller medical audiences, and the greater demands on their time, it was arranged with the County Medical Society that our two series be combined, the lectures to be given alternately at the County Medical Society and at Mitchell Hall. Thus, the first combined lecture was given at the County Medical Society in September by Dr. Mahlon Ashford, on the appropriate topic, "Coordination of Medical Society Activities." The October, Alvarenga Prize, Lecture, given at the College, was prepared by E. J. Cohn on "The Plasma Proteins: Their Properties and Functions." November brought the 20th James M. Anders Lecture given at the County Medical Society. Dr. F. G. Blake talked on "Epidemic Disease in the United States Army." The Thomas Dent Mütter Lecture in December was delivered by Dr. H. Winnett Orr on "Physiologic Protection from Infection in Wounds and Compound Fractures." All of these lectures, except Dr. Blake's, have appeared, or will appear, in our *Transactions & Studies*. Two lectures were given for the general public: one by Dr. Francis R. Packard on "The Diagnosis of Diseases of the Lungs and Heart: Stethoscope to X-ray," on January 16; the other on "Superstition and Medical Progress in Relation to the War," by E. B. Krumbhaar, on March 20. Both, like Dr. Beardsley's in the preceding November, were well attended; but in view of the increasing difficulties of the war situation, it was decided not to arrange any more for the next academic year.

The scientific work of 4 of our 5 Sections has progressed much as usual, except for an increased number of combined meetings with other societies, such as the Otolaryngology Section and the Philadelphia Laryngological Society, and meetings with similar sections of the County Medical Society. The Section on Medical History, with a membership of 58, after 5 good meetings, wisely decided last fall in view of the war situation to discontinue its sessions for the duration. Its officers, Drs. Laplace (now on active service) and Leaman, will continue until a new election is held. The Section on General Medicine, with a membership of 120, has held 5 meetings with an average attendance of 65. Its chairman and clerk, Drs. Fitz-Hugh and Gordon, both being on active service, their places have been filled by Drs. C. L. Brown and F. W. Sunderman. The Section on Ophthalmology, officered by Drs. Cowan and Reese, has 52 members; it has held 7 meetings with an average attendance of 63. The Section on Otolaryngology (Dr. Houser, Chairman, and Dr. Hewson, Clerk) has also held 7 meetings with an average attendance of 46. The Section on Public Health, with 45 members, has held but 3 meetings but with the high average attendance of 75. Its Chairman was Dr. J. H. Arnett, its Clerk, Dr. C. F. Long.

The important Committee on Public Health, Preventive Medicine, and Public Relations has continued its joint meetings with the similar committee of the County Medical Society, under the alternating chairmanships of Dr. Joseph Stokes, for the College, and Dr. Keegan. The joint committee has made numerous studies and recommendations on public health matters, both following requests from the College Council, the Director of Public Health, and various social agencies, and on their own initiative. Thus, at the request of Dr. Owen, the committee has at various times made recommendations on curb restaurants and markets, sanitary control of food handlers, the formation of district health centers throughout the city, the establishment of divisions of industrial hygiene and of public health nursing in the City Department of Health. In support of the Director's requests for increased appropriations to cover some of these desiderata, members of the Committee, like myself, appeared before Councils and aided Dr. Owen in his successful efforts. The Committee's advice on the question of industrial nursing was sought by the Visiting Nurse Society; and, at Council's request, a study was made for the hospitals of the city of the increasing difficulties of the private nursing situation. At the request of the Germantown Community Council, a suggested change in the location of the Starr Center was studied and partly, at least, as a result of the Committee's approval, local opposition to the move was withdrawn. The Committee also studied the

important problems of city water supply and sewage disposal, and is now investigating, at Council's request, an apparent inadequacy in the teaching of mathematics and science in the Public Schools. I believe that we would have to search far back in our history to find a better record of the College's service to the public in any single year. If the work of this committee could be still further strengthened, as some of us hope, by the aid of a full-time expert in the study of public health problems and education, the College would not only be more fully discharging its self-imposed duties to the public—a function that the College is in a peculiarly good position to carry out—but it would also be separating itself still further from the time when it was known to taxi drivers as the place where the Nurses' Registry was located, and to a visiting public health inspector as an institution complacently contemplating its incunabula in innocuous desuetude, like Buddha contemplating his navel!

Of our private affairs, perhaps the most important advance was the creation of the new class of Honorary Associates. I was much pleased that first the Council and then the College accepted my proposal that this new group be created, to make it possible to honor outstanding laymen, not eligible to be Honorary Fellows, for their demonstrated interest in and contributions to the development of medicine or related sciences. Such Associates receive a suitably worded certificate, in Latin, similar to that given to Honorary Fellows. They pay no dues and do not vote, but are admitted to all other rights and privileges. When I add that William Henry Donner, Founder and President of the International Cancer Research Foundation, and Edwin G. Conklin, Professor of Biology (Emeritus) of Princeton University and President of the American Philosophical Society, both accepted this association, it is apparent that a desirable step has been accomplished.

This was the only modification requiring a change in our By-Laws. In our Rules of Council, the other instrument by which the College is operated, advantage was taken of the greater flexibility of our present By-Laws to modify various procedures, such as the method of voting for candidates. Today, for instance, for the first time, candidates have been elected entirely by postal ballot, so that the business of this afternoon meeting could be accelerated.

The affairs of the Library, greatly affected by the stoppage of many foreign periodicals, and the Treasurer's statement will not be considered here, as they will be published in the *Transactions & Studies*.

Our *Transactions & Studies* continue to be published four times a year by the Publication Committee, under the editorship of the librarian. A further change in the format using slightly smaller type and a larger type page permits an estimated increase of 38% in the printed matter on each page. The well-selected and valuable contents, the pleasing format, and the accurate text give our publication, I believe, a position in American medical literature that was never attained by the single book, appearing belatedly once a year, of the previous series.

The Hall Committee, again under the Chairmanship of Dr. Owen—Dr. Chamberlain having been forced to resign the chairmanship through pressure of other work—has rendered good service. The College lecture rooms have been opened to the Woman's Medical College for a lecture series, board meetings, Commencement Exercises and the Martha Tracy Memorial meeting, also to the Laennec Society, the International Association of Medical Students, and the Russian War Relief Society. Several of our guest societies have held dinners at the College before their scientific programs. In spite of the cessation of the D.P.A. loan of extra helpers, the building has been kept in good condition; an air raid shelter and other precautions have been provided and fire hazard reduced by the sale of 18 tons of duplicate medical literature. Following Council's decision not to evacuate College treasures, appropriate possessions have been covered by the very inexpensive War Risk Insurance. Yielding to Mr. McDaniel's often expressed conviction that our valuable building required the full-time attention of a professional superintendent, the Committee has been fortunate in obtaining the services of an experienced building superintendent, Mr. Charles R. French, to begin the 22nd of this month. The Women's Committee has continued its faithful care of the Medicinal Garden. We have had many expressions of opinion that it has never looked better than in the past season.

The Entertainment Committee has continued to meet the deficit of our pre-meeting dinners, a deficit caused by the desire to keep subscriptions at the lowest practical level. As there have been no general entertainments, expenses have amounted only to about one-third of the year's income from the Weir Mitchell Entertainment Fund.

A number of gifts to the College have been gratefully received. Unfortunately, in view of our "tight" financial situation, only two have been in cash. Dr. David Riesman bequeathed $1,000 to the library, and the firm of Smith, Kline and French have made two contributions of $500 each for the year 1943 in recognition of the profit that their research department has derived from being allowed Special Library Privileges. It is reasonable to hope that other great firms will realize that they can make profitable use of our library and will express their gratitude in this very practical way. While all institutions naturally prefer unrestricted gifts, we must remember that, as in the present case, the gifts will free general funds for other much needed uses. I would like to suggest that our Fellows attempt, when appropriate, to correct the erroneous opinion that the College is a wealthy institution and to convince patients and friends that a gift or bequest to the College would be well placed. There are many valuable services that the College could and should perform which it is unable to undertake on account of lack of funds; and we would hope that at least the bequests would not become available until the present extraordinary demands for money no longer existed.

Among other gifts, we note Dr. Francis R. Packard's valuable collection of medico-historical lantern slides (with their negatives) and, more important, the gift by Mrs. Packard of an oil portrait of her husband. This is especially timely as the first portrait of a former President that we have received for some years. It is to be hoped that what was an almost complete collection of presidential portraits in Mitchell Hall will not be allowed to languish. A bust of another former president, Dr. W. W. Keen, and an oil portrait of Dr. Sajous were among other more notable gifts.

I am glad to call attention to the acceptance by Mr. Eric McCouch of the honorary position of Legal Counsellor. He has already given us helpful legal advice, just as Mr. Joseph Carson previously had done for a number of years.

We now have in the College a total of 716 Fellows (663 active, 45 Non-resident, 8 Honorary, of whom 3 are American and 5 Foreign) and 2 Honorary Associates. We lost through death in the past year 15 Fellows (12 active, 2 Non-resident, 1 Honorary).

Memoirs were read of Dr. James E. Talley (by Dr. Cottrell), of Dr. J. P. Crozer Griffith (by Dr. Hand), of Dr. Martha Tracy (by Dr. Catharine Macfarlane); and from this year's necrology list, of Dr. Edward A. Shumway (by Dr. Langdon), and of Dr. Herbert Fox (by Dr. Lucké); of Dr. W. T. Shoemaker, who died last November, a memoir has been prepared by Dr. Zentmayer. These have been, or will be, printed in the *Transactions & Studies.*

About the other 12 Fellows who died this year, I offer the following notes:

John W. Hunter, Non-resident Fellow, died June 22, 1942, at the age of 68. Graduated from the School of Medicine of the University of Pennsylvania in 1900, he served as assistant director of the Pepper Laboratories there, and practiced, with offices at 2042 Pine Street, in this city for 18 years. He was elected a Fellow of the College, October 2, 1912. In 1924 he moved to McDaniel, Maryland, where he lived until his death. I am glad to report that Dr. Hunter has included the College as a residuary legatee of part of his estate.

Charles A. Service was elected a Fellow, November 7, 1917. A graduate of Jefferson Medical College, 1882, he lived and practiced medicine for many years in Bala, where he died, June 22, 1942, at the age of 82. For some years he was surgeon and physician to the Pennsylvania Railroad and Christ Church Hospital, as well as consulting physician to the Home for Deaf Children.

Howard Leon Jameson was a graduate of the old Medico-Chirugical College, class of 1906. For some years he was professor of clinical medicine at the University of Pennsylvania Graduate School of Medicine and chairman of the Library Committee of the Philadelphia County Medical Society. He was a diplomate of the American Board of Internal Medicine and a Fellow of the American College of Physicians. He was elected a Fellow of this College, June 7, 1922. He died, after a brief illness, July 1, 1942, at the age of 61.

William Grant Shields, dermatologist to the Germantown Hospital and chief of dermatological clinic and assistant physician at the Jewish Hospital, died July 11, 1942, at the age of 63. He was graduated from the University of Pennsylvania School of Medicine in 1900 and elected a Fellow of this College, May 2, 1906.

Francis Joseph Kelly was graduated from Jefferson Medical College, 1894, as a Gold Medal member of his class. At the time of his death, he was staff consultant of St. Agnes, St. Vincent's, and Misericordia hospitals, and at one time was on the staff of St. Mary's Hospital. He was one of the founders of the Physicians' Motor Club and a former president of the Doctors' Golf Association.

During the first World War he served in the Army Medical Corps and held the rank of major when the war ended. For a time he was in charge of the Camp Grant (Ill.) Base Hospital. Elected a Fellow, October 1, 1913, he died September 3, 1942, at the age of 71.

Curtis Clyde Eves was elected a Fellow, November 6, 1912. He was a graduate of the Medico-Chirurgical College, 1905. He attended the University of Vermont, served his interneship at the New York Eye and Ear Infirmary, and did post-graduate work in Vienna. From 1912 to 1920 he was on the staff of the Episcopal Hospital. At the time of his death, September 22, 1942, at the age of 67, he was ear, nose and throat consultant at the Pennsylvania, Bryn Mawr, and Philadelphia General hospitals, and on the Executive Committee (at one time, chairman) of our Section on Otolaryngology. Formerly he was chief of the ear, nose, and throat service at the Pennsylvania and Bryn Mawr hospitals.

Robert Lucas Pitfield died suddenly October 3, 1942, at the age of 72. He was graduated from the University of Pennsylvania School of Medicine in 1892, and elected to Fellowship in this College, February 1, 1905. For many years he was on the staff of the Germantown Dispensary and Hospital. His "Compendium on Bacteriology," which appeared first in 1907, reached a 4th edition. He was of a literary turn of mind, and published, especially in his later years, a number of medico-historical papers. His subjects were often the more neglected and obscure figures in the history of medicine, though he was a great admirer of better-established figures such as Sir Ronald Ross (whom he knew personally) and Sir Patrick Manson. These interests led him to play an active part in the proceedings of our Section on Medical History and in the deliberations of our Library Committee, of which he was a member as recently as 2 years ago. The kindest and warmest hearted of men, his mind teemed with altruistic projects and he unobtrusively aided many deserving charities.

James Torrance Rugh was a graduate of Adrian College, Michigan; and of Jefferson Medical College in 1892. From 1918 to 1938, he was professor of orthopedic surgery at Jefferson, becoming emeritus professor on his retirement in the latter year. A member of the staffs of Jefferson, Methodist, and Philadelphia General hospitals, he was the author of many articles in his specialty. In the first World War he served in the Medical Reserve Corps, organizing standard methods of prophylactic orthopedic practice in camp and base hospitals. In 1918 he was commissioned a lieutenant colonel in the Army Medical Corps. He was elected a Fellow, February 1, 1905, and died, October 12, 1942.

Edward Jackson, who died October 29, 1942, at the age of 86, was elected to the College in 1885; this caused him to be for some years the earliest elected of the Fellows still living. An internationally famous ophthalmologist, he practiced, at first, in West Chester and Philadelphia after graduating from the University of Pennsylvania School of Medicine in 1878. From 1888 to 1894, and again from 1896 to 1898, he was professor of diseases of the eye at the Philadelphia Polyclinic, serving also as surgeon to the Wills Eye Hospital during this period. He became a Non-resident Fellow in 1899. For the greater part of his career, Dr. Jackson lived in Denver, where he was professor of ophthalmology at the University of Colorado School of Medicine, 1905–1921. He retained a non-resident fellowship in the College from his removal to Denver until his death, and this association was appropriately signalized in 1938 when Dr. Jackson came on from Denver to deliver our Section on Ophthalmology's first de Schweinitz Lecture. A memoir of Dr. Jackson, prepared by Dr. Chance, is to appear in the *Transactions & Studies*.

Luther Crouse Peter, another of our distinguished ophthalmologists, died, October 3, 1942, at the age of 73. He attended Susquehanna University, Gettysburg College, and the University of Pennsylvania School of Medicine, from which he obtained his medical doctorate in 1894. In 1910 he was appointed assistant professor of ophthalmology in the old Polyclinic Hospital (now the Graduate Hospital), and from 1917 to 1930 was professor of ophthalmology at the Temple University School of Medicine. In 1919 he was made professor of ophthalmology at the University of Pennsylvania's Graduate School of Medicine, which post he held until 1914, when he became professor emeritus. At the time of his death he was consultant on eye diseases at the Rush, Roxborough Memorial, and Friends' hospitals. He was a former president of the American Board of Ophthalmology and of the American Academy of Ophthalmology and Otolaryngology; a fellow of the American College of Surgeons; a member of the American Ophthalmological Society and the Oxford (England) Congress of Ophthalmology, and former secretary of the International Congress of Ophthalmology. He

contributed extensively and importantly to the literature of his specialty. He was elected a Fellow of the College on October 3, 1917.

R. Powers Wilkinson was elected a Fellow on March 4, 1936. He was born in Philadelphia on January 30, 1872 and died on December 2, 1942. Dr. Wilkinson graduated from the Medico-Chirurgical College in 1899. In addition to conducting his private practice, he served as physician to Moyamensing Prison, and for some years as Treasurer of the Philadelphia County Medical Society.

As I try to evaluate the changing state of our College in the past 3 years, I believe that it is best summarized as a further expansion of the trend toward greater liberality and flexibility—a library developed more for use and service than as merely a cherished possession, broader but no lower standards of Fellowship eligibility, more liberal loan of our halls to other organizations, more concern with the public health of our city and state, more coöperation with other medical societies, always with maintenance of the highest possible levels of scientific programs and memberships and additions to our possessions.

In conclusion, I wish to emphasize how deeply I appreciate the honor that was conferred on me with election to this office. Though I believe the College has continued to prosper during my term of office, I am well aware of how much more might have been accomplished, and hope that some of these desiderata may be realized in the near future. I hope, too, that "the near future" may include even those items which have to wait for the end of the world conflict.

Annual Report on the Library[1]

It has been our custom in recent years, in these Annual Reports, gently to lead the gentle reader along a path of attempted interpretation and prophecy to a point where there bursts upon his vision the splendor of the ever-ascending Vital Statistics for the year. Though these are extraordinary days, in which vital statistics inevitably reflect the planetary disorder, the need for animating words abides with us in good times and bad; and so we carry on our custom, this year touching on one or two relatively recent developments in the field of library coöperation and on our relationship to them.

The Inter-library Loan. The time is not long since institutional libraries such as ours functioned pretty much as Free States: each had its constituency; tariffs were high and inter-institute commerce almost non-existent. One library could scarcely tolerate the humiliation of borrowing from another.

Obviously, the larger a library is, the less likely it is to have to depend on other libraries to meet the needs of its constituency. But, just as obviously, even the largest libraries are occasionally unable to provide a work urgently needed by one of their constituents. In the wake of the modern, larger concept of libraries as linked units in the general pattern of a nation's cultural resources, the inter-library loan has in recent years developed from a haphazard, morally dubious, practice into a standardized, almost universal, service with various printed "codes" designed to satisfy the still sometimes temperamental restrictions of the libraries in a given area. Though conservatism beyond the needs of conscientious safeguarding of valuable property is still occasionally met with—in general, one may say that a favorable response to a request for an inter-library loan no longer depends on various personal factors, but merely on whether the given book is permitted to be taken out of the library at all; the transaction is now a routine one carried on without the head librarian's intervention, except in extraordinary cases.

Though for many years we had evidently borrowed from the Army Medical Library often enough to justify the printing of request-forms, there are no records to indicate that we extended a similar courtesy to other libraries, and the first of our Reports even to mention an inter-library loan service was that for the year 1935. We suspect that it was the small number of volumes loaned that led us therein to refer only to the relatively more impressive number of States to which we had sent volumes on loan. In the Report for 1938 appears our first mention of the number of volumes (66) loaned and the number of borrowing libraries (17), as well as the number of States. How welcome the development of this service has been to other libraries is indicated in our current Report, which shows that in the past year we loaned 206 volumes to 27 libraries. Bounded as we are by the Army Medical Library on the South, by the New York Academy of Medicine library and the Boston Medical Library on the North, it is probable that requests made of us will never exceed our ability to handle them or affect the fulfilment of our primary duty, which is, of course, to serve our Fellows. What we wish to emphasize here are the development of the inter-library loan into a routine practice and the fact that the relaxation of our earlier attitude toward lending freely is proving of considerable advantage to libraries less fortunately situated, without appreciably affecting the discharge of our primary obligations. On the other hand, we sometimes feel that *our* readers are not as aware as they might be of this service, which could bring to them material that often would be inaccessible to them as individual borrowers.

Union Library Catalogues. It is one thing, of course, to have achieved a mechanism by means of which a much-desired volume may be brought to one from another library, quite another to discover what library has the volume for the mechanism to work on. In the old days, if a reader wanted the book badly enough for his librarian to undergo the uncertainties and trouble involved, the latter wrote around to libraries that he thought *might* have it—sometimes discovering too late that the book was to be found only in a library that no one would ever suspect of harboring it.

Here in Philadelphia we have been blessed in the last half-dozen years by the development of a Union Library Catalogue embracing some 150 (including all the major) libraries in the Philadelphia Metropolitan Area. Neither of the cities in the United States larger than ours can boast of a

[1] October 16, 1941 to October 15, 1942.

similar coöperative achievement. In a few moments one can ascertain the location of any one of the 5,500,000 volumes held by libraries in this area. Should a desired book not be found in any Philadelphia library (which can happen; the Union Library Catalogue reports that in the past year it was able to locate only 60 per cent of the works about which there were inquiries), the Union Library Catalogue will consult the National Union Catalogue of the Library of Congress, and, that source failing, it will circularize the 50-odd other national or regional catalogues. Thus the problem of locating a book, which is even more essential than that of providing a mechanism for its loan, has become immeasurably simplified and will become even more so as the network of union catalogues in the country becomes more extensive and coördinated on a national basis.

Great and encouraging as has been this development, it will not be of maximum service to special libraries such as ours until these libraries are included in either a National Union Catalogue with a really comprehensive coverage or in sufficiently large regional catalogues. The Army Medical Library's *Index-catalogue* and *Current list of medical literature* keep us reasonably up-to-date on the holdings of our National medical library; the Philadelphia union catalogue gives information as to the holdings of our local medical libraries (to it must unquestionably be attributed in large measure the greatly increased number of requests made of us for loans); the Union List of Medical Literature in the more important libraries in the state of Massachusetts, begun in 1939 by Mr. James F. Ballard, Director of the Boston Medical Library, will, when completed, be of great service to many New England libraries and probably to others. A few other important medical libraries are entered in regional or subject catalogues; but many others, including the great library of the New York Academy of Medicine, have as yet no fold to come into. Nevertheless, one may confidently look forward to a not-too-far distant day when it will be possible to locate quickly any book in a medical library in the United States and (except in the case of rare books) borrow it *sans peur et sans reproche*—unless a microfilm copy of it be mutually more desirable.

Microfilm. Now, sending books through the mails or by express on inter-library loan has two distinct disadvantages which are soon observed by the lending libraries: 1) the material is subject to loss or damage; 2) the time lost in transit occasionally inconveniences readers in the home library.

In the case of a short article or passage the borrower can sometimes be persuaded to invest in a photostatic copy; the cost of photostating a passage of considerable length, however, is great enough to prevent common use of this form of reproduction. But once again science has come to our assistance, this time with the microfilm.

Our library's situation as regards the microfilm is not yet quite satisfactory. The Medicofilm Service at the Army Medical Library, and Microfilms, Inc., at Ann Arbor, make it possible for us to obtain microfilm copies of any medical work available to these services. We have a reading machine. So far so good. What is not available in the city at present is a microfilm laboratory able to reproduce for us wholly or in part the works for which inter-library loans are requested. Various local institutions—such as the two universities, the Historical Society, and the American Philosophical Society—for a time were equipped with microfilm laboratories and generously attempted to serve the institutions without them. But war conditions have caused a suspension in the work of these laboratories, and the one or two commercial firms are so preoccupied with Government orders that they are unable to respond to private demands on them. It is probable that the American Philosophical Society, always in the forefront in matters of library coöperation, will re-establish its laboratory in this emergency. What we are really looking forward to, however,—and the project is already under consideration by the Philadelphia Metropolitan Library Council—is the establishment of a central laboratory run coöperatively by our local libraries and equipped primarily to meet their needs. Such a service seems quite in line with the growing trend toward inter-library coöperation and, if established on a sound basis, with rapid service at reasonable cost, should prove of great value to all our cultural and scientific institutions.

It must be confessed that, so far as this library is concerned, our readers have yet to make any extensive use of the Union Library Catalogue, of the inter-library loan and microfilm services. It would be a sign of the most outrageous complacency to attribute this to a possibility that our own resources are quite sufficient to our readers' needs. That is our aim, of course, but it is one that never can be wholly realized. Readers do want, more often than the statistics reveal, material that we do not have. If this material is not sought out and

brought to them, it is partly because the readers themselves accept defeat too easily (or kindly); partly because we do not make them realize forcefully enough how comparatively simple and painless a matter it is these days to summon from any corner of the country the original, or a copy, of almost any material reposing in the libraries of our land. It is our thought here to suggest that perhaps all of us have accepted too casually these great material and spiritual gains that tend to draw libraries closer together in the brotherhood of service to all who wish to know.

Miscellaneous Notes

Collections. A fine new collection to be reported, and one which creates for us another medico-historical cell, is Dr. Francis R. Packard's notable collection of 1,200 lantern slides used by him in his historical lectures. It need hardly be suggested how useful this collection will be, especially after the war, when once again the past can vie on more nearly equal terms with the present for our attention.

Dr. Samuel Booth Sturgis, Honorary Director of our Department of Medical Art, worked steadily on the assembling, mounting, and describing of the heterogeneous material which is now properly called the Sturgis Collection of Medical Art. This monumental project, which will receive detailed attention when it is completed, already has assumed a most impressive aspect. During the year there was added to it, as the gift of Dr. Samuel McClintock Hamill, a splendid collection of rare old medical engravings. Mounted by Dr. Sturgis, a goodly number of the rarest and most interesting of these served as one of the most commented-upon of our exhibits for the year.

Rariora. "Notes from the Library" in the December, 1942, issue of this periodical brought to attention some of the year's acquisitions of *rariora.* It is fitting that mention be made of a few others. Mrs. Frank Read presented, through our Fellow Dr. C. A. E. Codman, autograph bills of three early Philadelphia physicians, Thomas Bond, Thomas Thomasson, and George De Benneville. Dr. Bradley gave us three documents connected with the life of one of our Fellows of the last century, Bernard Henry: 1) his medical diploma from the University of Pennsylvania, 1844; his commission in the U. S. Navy, 1846; and 3) his certificate of fellowship in this College, 1855. Dr. Harry Friedenwald, of Baltimore, a long-time friend of the Library, presented us with a fine copy of C. G. T. Ruete's *Bildliche Darstellung der Krankheiten des menschlichen Auges* (Leipzig, 1854), which enabled us to retire our incomplete copy. The library, for its part, added two little volumes to its collection of 16th century medical publications: 1) Libri epidemiorum Hippocratis primus, tertius, et sextus, cum Galeni in eos commentariis. Jo. Vassaeo Meldensi interprete. Ed. 1a. Lugduni, Rovillius, 1550; 2) Methodus generalis, & compendiaria, ex Hippocratis, Galeni, & Auicennae placitis deprompta . . . Alfonsi Bertotij Fanensis opera hinc inde collecta . . . Lugduni, Coterius, 1558. Each brings to our historical section a translation or a collection not hitherto represented therein.

Activities. The major exhibits seemed largely to radiate from the Department of Art, whose resources for such purpose seem inexhaustible. There was an exhibit of the work of the late Erwin Faber; one of a selection of the Hamill prints, already referred to; and one of the Bradley collection, which was also drawn upon to illustrate an exhibit of early manuscript lectures and student notes on them. In honor of the annual meeting of the National Tuberculosis Association, held in Philadelphia, we presented an exhibit for which we were able to draw upon the remarkable Lawrence F. Flick collection in the library. As usual, there were many secondary exhibits presented in connection with the meetings of the Section on Medical History, the Public Lectures, and other special occasions.

At the request of the librarian of the Woman's Medical College, we inaugurated a projected annual conference in our library with the first-year students of that College. They were told something about the library and how to use it. Each was supplied with a mimeographed list of reference works and with a reference to locate in one or other of them. At the end of a given period we reassembled and discussed the reasoning which led to success or lack of it in tracking down the various references. The conference seemed to us so pleasant that we hope, after the war, to be able to extend the practice to the other medical schools.

The library instituted, and participated with some five or six of the other large local libraries in, a coöperative project to locate, via the Union

Library Catalogue, any Philadelphia-held copies of *Short-title Catalogue* books of which no American-owned copies had then been located.

The librarian served as vice-president of the Philadelphia Metropolitan Library Council and as chairman of its Committee on Specialization; most of the meetings of the Council's Executive Committee were held in the College building. The library was represented by the librarian at the annual meeting of the Medical Library Association at New Orleans, in May, doubtless the last of such meetings until the end of the war.

Articles (by E. A. Schumann; the librarian; W. S. Middleton) based on material in the library appeared in the December 1941, February 1942, and April 1942 numbers of the College's *Transactions & Studies*.

The Staff. The year has seen momentous changes in the library staff. We lost, for one reason or another, our assistant cataloguer, Miss Sallie H. Todd (Mrs. Carroll), Mrs. John Toms, part-time assistant, Miss Marion Jackson, junior assistant and photostat operator, and her immediate successor, Mr. William Belcher. Most of these defections took place in the early part of the summer. On August 1st, Miss Gertrude Bishop, our cataloguer, who had been a member of the staff for forty years, was retired on pension. The engagement of her niece, Miss Hertha Bishop, terminated at the same time.

Miss Clara Manson, who had just completed a year's resident Fellowship at the medical library of Tulane University, after several years previous library experience, succeeded Miss Bishop as cataloguer on August 1st. Miss Ruth Yarger, fresh from graduation from the library school of Drexel Institute, was engaged to replace Miss Todd as assistant cataloguer. Mr. Belcher was succeeded by Miss Eleanor Mars as junior assistant and photostat operator. A short time after Miss Hertha Bishop's retirement, Miss Kathryn Haegele was moved up to her position, and Miss Mary Mars was engaged to fill Miss Haegele's former position. It is thought that the position of part-time assistant, vacated by Mrs. Toms, will not have to be filled until the end of the war brings a resumption of the receipt of foreign periodicals. Through all this the library has been fortunate in being able to rely on the steadfast spirit and capabilities of the three remaining members of the old staff, Miss Helen Jackson, Miss Kathryn Haegele, and Mr. R. H. Baugh. To the last of these the Library Committee and the librarian have already expressed particular indebtedness for his having voluntarily relinquished two weeks of his summer vacation in order that there might be at least a semblance of "business as usual" during those trying hundred days. Now our sail is set once again, we have an able and high-spirited crew; our little ship will stick to its course as best it can, come hell and high water.

Inventory

	1942	1941	1942	1941
Total number of accessioned items[2]			159,188	157,525
Incunabula	413	412		
Manuscripts	594	540		
Other items[3]	158,181	156,573		
	159,188	157,525		
Total number of unaccessioned items[4]			321,989	320,986
Reports and Transactions	25,696	25,623		
Periodicals "reserve"[5]	4,683	4,659		
More or less complete volumes of other periodials not regularly received	2,706	2,867		
Theses and Dissertations	47,489	47,301		
Pamphlets (less than 100 pages)	241,415	240,536		
	321,989	320,986		
Total number of current periodical publications regularly received			670	1,029
Duplicate books			14,522	13,998
Portraits[6]			54,653	52,070

Distribution of This Material

	Accessioned Items	Unaccessioned Items
General Library (including the Lewis Library)	154,965	321,985
On permanent deposit:		
Gross Library	3,806	4
Parry Library of the Obstetrical Society of Philadelphia	217	0
Mütter Museum[7]	200	0
	159,188	321,98

[2] An accessioned item may be any kind of material that is kept within covers, whether these be made commercially or in the library, of paper or of more durable material. The accessioned item might comprise, for instance, part of a book, or one or more books; a part of a periodical volume, or one or more complete volumes; reports, pamphlets, or theses, single or collected; an atlas or photograph album.

[3] Including 40 'rare' books acquired during the year.

[4] While the accessioned items contain some material in paper covers, it should be noted that most Reports and Transactions, pamphlets, and theses, also paper-covered, are not accessioned, but that any of them might be, if any intrinsic reason for so doing should present itself.

[5] More or less complete duplicate volumes of important and much-used periodicals.

[6] Including 109 oil, and 460 other, framed portraits in the care of the Committee on College Collections. The count of portraits represents the number of entries on the cards in the portrait catalogue. The entries represent, in turn, both loose portraits and those in books, many of them, of course, being merely different reproductions of a single original.

[7] The books of the Mütter Museum are not permitted to be removed from the College building.

Current Periodicals

Total number of periodicals regularly received in the library: 670 titles

	Purchase	Exchange	Gratis	Annuals & 'Books'	Total
American (United States)	171	67	156	61	455
Australia and New Zealand	1	3	1	2	7
British Isles	67	15	9	3	94
Canada	1	6	8	1	16
Ceylon and India	2	4	1	0	7
Cuba and Puerto Rico	1	6	8	0	15
Egypt	0	1	0	0	1
Mexico and Guatemala	2	5	4	0	11
South Africa	0	2	1	0	3
South America	8	20	19	3	50
Sweden	0	1	0	0	1
Switzerland	8	1	1	0	10
Totals, 1942	261	131	208	70	670
Annuals & 'Books'	26	11	33	70	
Grand Totals, 1942	287	142	241		670
Grand Totals, 1941	602	187	240		1,029
Grand Totals, 1940	645	230	259		1,134
Grand Totals, 1939	688	248	266		1,202

No 1942 issues have been received of journals published in Belgium, the Netherlands, France, Denmark, Norway, Italy, Germany, Japan, or China. Hence the large drop of 360 from the total number received a year ago, as compared with the more gradual decline in other years since the war began. Not included in the tabulation are 112 journals (all but three of them published in the Western hemisphere) of which one or more numbers were added to the files, scattered issues (current or otherwise) having been received by donation.

New titles: Of the 50 publications added to our list during the year, 21 are received by purchase; 3, by exchange; 26 gratis. Twenty-eight of these are journals which have recently begun publication and are now on file from the first number issued.

Separate issues received and filed: 10,799 (exclusive of duplicates, 8,704, and of reserves, 933). Of this total, 3,173 were scattered issues received from Fellows and other donors; and 96 others were previously-lacking back-numbers supplied by publishers or editors in response to claims. Although this year's total is only 1,600 fewer than the year before, the drop in number of current journals received by mail from publishers is much greater: 7,500 received this year as against 9,800 last year. The number of donations from local sources increased considerably: 645 more journals were kept for our files, and 6,468 more duplicates received than in 1941.

Visitors to the Current-periodicals Room during the year were recorded to the number of 5,184—a decrease of 600 from the number for the preceding year. Of this year's total, some 860 were visitors during the 82 evenings the library was open (160 fewer visitors than the year before, when the library was open 12 fewer evenings); and 282 were visitors on 31 Sunday afternoons (50 persons fewer than in 1941, when there were 4 more Sunday openings).

Readers' Use of the Library

Library hours: the library was regularly open daily, except Sunday, from 9 to 6; on Wednesday and Friday evenings until 9:30; on Sunday afternoons from 2 to 5:30 (October 5, 1941 to May 10, 1942). From June 1 to September 4, incl., the library was open Mondays to Fridays, incl., from 9 to 5, and closed on Saturdays and Sundays. The library was closed, as usual, on the following legal holidays: Thanksgiving, Christmas, New Year's, Memorial, Independence, and Labor days.

			Fellows		*Non-Fellows*		*Totals*	
	1942	*1941*	*1942*	*1941*	*1942*	*1941*	*1942*	*1941*
Number of visitors:								
Days	(293)	(289)	1,586	1,607	6,840	7,640	8,426	9,247
Evenings	(84)	(70)	137	180	1,027	1,255	1,164	1,435
Sundays	(31)	(35)	27	35	474	610	501	645
			1,750	1,822	8,341	9,505	10,091	11,327

Circulation of books:

	1942	*1941*
Number of volumes taken out	7,277	7,768
(Books: 3,443; Periodicals: 3,834)		
Number of volumes consulted in the library[8]	40,725	44,825
(Books: before 1700, 88; before 1850, 555; after 1850, 10,412)		
(Periodicals: before 1850, 310; before 1899, 786; after 1899, 28,574)		

Inter-library Loans: The library has sent 206 (1941: 141) volumes on inter-library loan to 27 (1941: 24) libraries in 12 (1941: 16) States, and has borrowed 17 (1941: 14) volumes from 5 (1941: 6) libraries. There were, as happens each year, a number of requests we could not fill: 14 volumes asked for we did not have; 5 are on the restricted list; 8 requests were for current, unbound journals. Our photostat answered the need in some of these cases, and in many more a knowledge of this service obviously forestalled a request for loan of a volume. Our borrowings were chiefly from the Army Medical Library, but the Boston Medical Library, the John Crerar Library, the Library Company of Philadelphia, and the Library of Yale University also graciously answered requests for loans.

Photostats: 1,977 photostatic prints have been furnished to Fellows (1941: 1,345); 435 prints to non-Fellows (1941: 482); 228 prints to the library. The last include a copy of an incunabulum (bringing the total of photostated incunabula to 315), portraits, rare books on loan, etc.

Acquisitions and Accessions

Received from all sources:[9]

1942: 2,396 volumes (including the bound and accessioned volumes of periodicals, 81 unbound reports and 652 duplicates); 1,532 pamphlets; 238 theses; 21,614 numbers o various journals.

1941: 3,215 volumes (including the bound and accessioned volumes of periodicals, 65 un-

[8] The number of volumes "consulted in the library" includes only those supplied on demand. Readers have access to the bound volumes of periodicals and works of reference kept on the shelves in the Reading Room; the Fellows of the College, and occasionally others by special permission, have access to the bookstacks. There are, therefore, many volumes consulted of which no accurate record can be kept.

[9] As usual, not all the pamphlets, theses, and numbers of various journals listed as received had been checked for keeping or discard at the close of the library year.

bound reports and 447 duplicates); 1,915 pamphlets; 430 theses; 16,203 numbers of various journals.

Accessions:

1942: 1,663 volumes (809 by purchase; 574 by gift; 280 by exchange). (Books, 658; Periodicals, 1,005.)

1941: 2,703 volumes (1,067 by purchase; 1,015 by gift; 621 by exchange). (Books, 902; Periodicals, 1,801.)

Donations

The individual donors for the past year number 231 (1941: 248).

The library is indebted for large gifts of books, pamphlets, and unbound periodicals to the following donors:

P. Blakiston's Son & Co.; Drs. C. W. Bonney, W. N. Bradley, Burton Chance, Samuel Cohen; F. A. Davis Co., Episcopal Hospital Library; Drs. J. P. C. Griffith (bequest), S. McC. Hamill, Maxwell Herman, E. B. Krumbhaar; Lea & Febiger; Drs. F. H. Leavitt, S. A. Loewenberg; Medical Library Association Exchange, The Nurses' Directory; Dr. F. R. Packard; Philadelphia General Hospital, Nurses' Home; Drs. G. M. Piersol, A. C. Sautter; Sharp & Dohme; Dr. J. F. Sinclair; University of Pennsylvania Library; Drs. Joseph Walsh, P. F. Williams; Women's Hospital, John Wyeth & Brother, Inc.; Dr. William Zentmayer.

Various publishing houses have presented volumes as follows: P. Blakiston's Son & Co., 4; Commonwealth Fund, 1; F. A. Davis Co., 5; A. A. Knopf, Inc., 1; Lea & Febiger, 18; J. B. Lippincott Co., 6; W. B. Saunders Co., 41.

Eight volumes were presented by the following authors or editors: W. P. Eagleton, J. L. Fetterman, F. K. Knowles, E. F. Corson & H. B. Decker, J. A. Lavergne, H. C. Naffziger, J. P. Schaeffer, I. S. Tassman, F. D. Weidman, Homer Wheelon.

Exchanges

The *Transactions & Studies* was sent, either as gift or in exchange for 233 other serial publications, to 285 organizations.

Thirty-three distributions (774 unbound journals and 21 bound volumes) have been made through the Medical Library Association Exchange. The library has received forty-three such distributions.

Theses and dissertations to the number of 111 have been received from the following European schools of medicine with which we exchange publications at the present time: Universities of Basel, Bern, Lausanne, Lund.

Work of the Cataloguers

	1942	*1941*
Number of works classified, shelf-listed, and for which cards were filed	903	859
Cards typewritten, examined and filed	9,854	9,680
Other cards altered and filed	7,076	10,671
Pamphlets and reprints subject-headed and arranged alphabetically by subject, and by author under the subject	403	884

W. B. McDaniel, 2d
Librarian

Approved:
William Egbert Robertson, M.D.
Chairman

Annual Report of the Committees of the Mütter Museum and College Collections

The Museum

The Museum was open to Fellows and guests on days when the College building was open, from 10 to 1 and from 2 to 6, except Saturdays, when the hours were from 9 to 1. During these hours the clerk-technician, Mrs. Wade, was constantly in attendance. In addition, the Museum was open on the evenings of the Stated Meetings of the College, the clerk-technician being in attendance. At the request of some of the Sections of the College, the Museum was open an hour or two before certain of their meetings.

Dr. Ralph Pemberton delivered his annual lecture at the College on October 15th and used a number of the arthritis and ankylosis specimens from the Museum for illustration.

The clerk-technician reports more than 700 visitors registered during the year. There were, of course, visitors to the Museum who failed to sign the Register. The number of visitors, Fellows and others, during the year, would appear to indicate a growing interest in the Museum. This is, in a large measure, due to the courtesy and constant attendance of the present clerk-technician.

The Committee wishes to express its appreciation to Dr. Joseph McFarland, the curator of the Museum, and to Mrs. Wade, the clerk-technician, for their attention and interest during the year.

The Thomas Dent Mütter Lecture LV was given by Walter L. Palmer, M.D., Professor of Medicine, University of Chicago, who spoke on "The Role of Acid Gastric Juice in Gastric and Duodenal Ulceration." This lecture was printed in the *Transactions & Studies*, 4th ser., vol. 9, No. 4, pp. 191–200 (February, 1942).

Dr. Joseph McFarland was reappointed curator of the Museum for the year 1942–43, and Mrs. Ella N. Wade was reappointed clerk-technician for the year 1942–43.

A paper entitled "The Petrified Lady" was prepared by the curator, Dr. Joseph McFarland. The paper deals with the adipocere body that is on display in the Museum. It was published in our *Transactions & Studies*, June 1942, and in the *Annals of Medical History*, July, 1942.

Accessions to the permanent collection of the Museum, during the year, and subject to the Mütter Deed of Gift, were as follows[1]:

1. Two lithotrites; two bladder sounds; a perineal lithotome. Presented by Dr. Charles W. Bonney.

2. Circumcision set with astringent and haemostatic powder, circa 1830, used by Dr. Henry Heller, Major, 27th Pennsylvania Infantry, 1861. Presented by his grandson, Dr. Edwin A. Heller.

3. Refractometer. Presented by Dr. Douglas Macfarlan.

College Collections

Dr. Joseph McFarland was reappointed Curator of the College Collections for the year 1942-43, and Mrs. Ella N. Wade was reappointed clerk-technician for the year 1942-43.

Accessions to the College Collections were[1]:

1. Two framed pictures: Dr. William Crawford Gorgas; Professor Anton Weichselbaum. Presented by Dr. Samuel McClintock Hamill.

2. A small fur muff in a leather box, said to have been carried by Dr. John Foulke, when he drove to Valley Forge, so that his hands would not be too stiff to operate. Presented by the Foulke and Long Institute through Mrs. Randall Chase.

J. Parsons Schaeffer, M.D.
Chairman

[1] For further acquisitions during the year, see the *Transactions & Studies*, 1942–3, *10*, 185 (December 1942).

Annual Report of the Publication Committee

THIS report covers the four issues of the *Transactions & Studies* published within the past fiscal year; namely, vol. 9, nos 3 and 4, vol. 10, nos 1 and 2. There follows a brief statement of income and expenditures:

Income

Appropriation	$1,100.00
Sales and reprints	131.95
Publication funds	618.01
	$1,849.96

Expenditures

Printing and mailing	$1,601.91
Reprints	154.93
Envelopes	25.70
Stenciling	20.00
Postage, stationery, etc.	12.50
	$1,815.04
Balance, November 30, 1942:	$34.92

At the suggestion of our printers, the Waverly Press, and as a war measure, the size of the type page, beginning with vol. 10, no. 1, was reduced to 33 x 50 picas, which is 2 picas wider and 2 picas longer than the type page we had been using for several years. At the same time, the 10 on 12 point type formerly used was replaced by 9 on 11 point type. The combination of larger type page and smaller type is estimated to effect an increase of about 38 per cent in the number of words per page, and, of course, a corresponding saving in text paper. Further to conserve paper, the sinkage of the first page of each communication was reduced from 4 to 3 picas. While these changes are perhaps not apparent to the casual reader, they do diminish the legibility and attractiveness of appearance of the page, and it is expected that after the war we shall return to the earlier format.

Since we continue to export copies of the *Transactions & Studies* to the allied countries, beginning with vol. 10, no. 2 (June, 1942) we have been required to obtain an export license from the Office of Censorship for each issue.

Over the quality of the scientific communications we have, of course, almost no jurisdiction, since they are the lectures delivered at the regular meetings of the College. But we believe that the Committee on Scientific Business and the various lectureship committees have provided lectures of a somewhat higher standard than usual. We were fortunate in obtaining for the section of historical articles Col. Hume's "Scientific Accomplishments of the United States Army Medical Corps", published in two parts, and soon to be brought out, somewhat expanded, by Lippincott's as "Victories of Army Medicine"; Dr. Schumann's "William Hunter Lecturing on Obstetrics and Infant Care" (reproducing a manuscript in the library of the College); Dr. William S. Middleton's "Manuscript Notes of John Syng Dorsey" (based on other manuscripts in the library); and another one of Dr. McFarland's delightful articles based on interesting material in the Mütter Museum.

We anticipate for the duration of the war a diminution in the number, and perhaps in the quality, of the communications. An arrangement has been made with the Philadelphia County Medical Society by which lectures delivered at the joint meetings will be available for publication by both institutions; as the Society's publication is not covered by the medical indexes, no duplication therein will result. For the sake of maintaining the College's one regular contact as an institution with national and international institutions of like aim, as well as for the sake of the library's use of the magazine for exchange with 233 other medical periodicals, it is deemed important to carry on this activity, and on as high a plane as circumstances may permit.

W. B. McDANIEL, 2d
Editor

Approved:
JOHN P. SCOTT
Chairman

List of the College Lectures, 1942

SCIENTIFIC LECTURES

January 7

MUSSER, J. H. The Heart That Is Ageing (Benjamin Musser Lecture I). (*Transactions & Studies*, February, 1942.)

February 4

MCCAY, CLIVE M. Nutrition, Ageing and Longevity (Nathan Lewis Hatfield Lecture XXVI). (*Transactions & Studies*, April, 1942.)

March 4

DUBOS, RENÉ J., AND HOTCHKISS, ROLLIN D. Origin, Nature and Properties of Gramicidin and Tyrocidine (Mary Scott Newbold Lecture LI). (*Transactions & Studies*, April, 1942.)

April 1

BOCK, ARLIE V. Fatigue (James M. Anders Lecture XIX). (*Transactions & Studies*, June, 1942.)

May 6

BURWELL, C. SIDNEY. Studies of the Circulation in Congenital Affections of the Heart and Their Application to Some of the Problems of Heart Disease (Mary Scott Newbold Lecture LII). (*Transactions & Studies*, June, 1942.)

*September 23**

ASHFORD, MAHLON. Coordination of Medical Society Activities. (*Transactions & Studies*, December, 1942; *Philadelphia Medicine*, October 31, 1942.)

*October 14**

COHN, EDWIN J. The Plasma Proteins: Their Properties and Functions (Alvarenga Prize Lecture III). (*Transactions & Studies*, December, 1942.)

*November 11**

BLAKE, FRANCIS G. Epidemic Disease in the United States Army (James M. Anders Lecture XX).

*December 2**

ORR, H. WINNETT. The Physiologic Factors Involved in Protecting the Patient against Infection in the Healing of Fractures in Compound Wounds (Thomas Dent Mütter Lecture LV). (*Transactions & Studies*, February, 1943.)

LECTURES FOR THE GENERAL PUBLIC

January 16

PACKARD, FRANCIS R. The Diagnosis of Diseases of the Lungs and Heart: Stethoscope to X-Ray.

March 20

KRUMBHAAR, EDWARD B. Superstition and Medical Progress in Relation to the War. (*Transactions & Studies*, December, 1942.)

* Under the joint auspices of the College and the Philadelphia County Medical Society. The September and November meetings were held at the Hall of the Society.

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‡ = Memoir of the person named

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